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Muskeg River
Interim Management Framework for Water Quantity and Quality

Management Guidance for Aquatic Components of the Muskeg River Watershed

June 2008

Alberta
ENVIRONMENT

Muskeg River Interim Management Framework for Water Quantity and Quality

ISBN: 978-0-7785-7630-3

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Acronyms and Abbreviations

AENV	Alberta Environment
AEP	Alberta Environmental Protection
ASRD	Alberta Sustainable Resource Development
ASWQG	Alberta Surface Water Quality Guideline
ATC	Athabasca Tribal Council
BOD	biochemical oxygen demand
$CaCO_3$	calcium carbonate
CCME	Canadian Council of Ministers of the Environment
CEMA	Cumulative Environmental Management Association
DO	dissolved oxygen
DOC	dissolved organic carbon
DFO	Fisheries and Oceans Canada
EIA	Environmental Impact Assessment
EPEA	*Environmental Protection and Enhancement Act*
ERCB	Energy Resources Conservation Board
EUB	Energy and Utilities Board
FN	First Nation
GIS	Geographic Information System
HSPF	Hydrologic Simulation Program - Fortran
IFN	Instream Flow Needs
IRC	Industry Relations Corporation
km^2	square kilometre
m	metre
masl	metres above sea level
m/km	metres per kilometre

Acronyms and Abbreviations Cont.

m^3/s	cubic metres per second
mg/L	milligrams per litre
mg/m^3	milligrams per cubic metre
mm	millimetre
µg/L	micrograms per litre
µS/cm	microSiemens per centimetre
ng/L	nanograms per litre
NTU	Nephelometric turbidity units
RAMP	Regional Aquatics Monitoring Program
RSDS	Regional Sustainable Development Strategy
RSWQO	Reach Specific Water Quality Objective
SPAR	Suggest, Propose, Advise and Recommend
TDS	total dissolved solids
TEK	Traditional Ecological Knowledge
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
U.S. EPA	United States Environmental Protection Agency
WITG	Watershed Integrity Task Group
WQL	Water Quality Limit
WQT	Water Quality Target

Glossary

Acid Neutralizing Capacity	A measure of the potential of water to buffer itself against acid inputs.
Acute Toxicity	Adverse effects on the survival of an organism that occur within a short time following exposure to a chemical.
Ammonia	A form of nitrogen produced by the decomposition of organic material. In high concentrations it can be highly toxic to aquatic organisms. In most well-oxygenated waters, ammonia is converted to non-toxic nitrate, a nutrient necessary for plant growth.
Aquatic Ecosystem	Any ecosystem of which the principal component is water, such as ponds, lakes, reservoirs, rivers, streams, wetlands, riparian areas and groundwater systems. The *Water Act* defines aquatic environments as 'components of the earth related to, living in or on water or the beds or shores of a water body, including but not limited to: all organic and inorganic matter; living organisms and their habitat, including fish habitat; and their interacting natural systems'.
Biodiversity	The number and kinds of organisms or the composition of species in a given area at a given time.
Chronic Toxicity	Adverse effects on an organism that occur over the long term following exposure to a chemical. Behaviour, growth and reproduction of the organism may be affected.
Contaminant / Pollutant	A substance that in sufficient concentrations will impair water quality or result in toxic effects on aquatic life.
Cumulative Effects	Environmental effects that result from the incremental effects of one impact when added to all past, present and future impacts.
Discharge	The volume of water passing a particular point over a specified period of time. Also called flow.
Dissolved Oxygen	The concentration of oxygen available for plants and animals in the water. Sufficient DO concentrations are essential for the survival of aquatic life. As water temperature increases, aquatic respiratory demands increase but the solubility of oxygen decreases.
Ecosystem	A community of microbes, plants and animals together with their environment that interact and function as an ecological unit.

Glossary Cont.

Ecological Integrity	The degree to which the physical, chemical and biological components of an ecosystem (including their composition, structure and processes) and their relationships are present, functioning and self-sustainable. It is a measure of the ability of an ecosystem to support and maintain a balanced, adaptive system with a species composition, diversity and functional organization that is comparable to that of natural systems.
Ecosystem Functions	The processes through which the components of an ecosystem change and interact. The processes are dependent on the capacity of the ecosystem and certain aspects of its landscape, such as the water cycle or carbon cycle.
Ecosystem Health	A measure of the degree to which an ecosystem is sustainable and resilient to stress. Healthy ecosystems are capable of maintaining ecological structure and function over time, similar to pristine, undisturbed ecosystems. They have the ability to recover from disturbances, maintain ecological integrity over time, while continuing to meet societal needs and expectations.
Ecosystem Structure	The physical patterns of the individuals and communities within an ecosystem, including characteristics such as biomass, age, spatial distribution and rates of growth and reproduction.
Environmental Indicator	A measurement, statistic or value that provides evidence of changes in the state or condition of an ecosystem.
Freshet	Seasonal increase in streamflow due to spring runoff and/or meltwater.
Functional Ecosystem	An ecosystem that supports and maintains a balanced, adaptive system with a species composition, diversity and functional organization that is comparable to that of natural systems.
Habitat	The natural environment or specific surroundings where a plant or animal grows or lives. The surroundings include physical factors such as temperature, moisture and light together with biological factors such as the presence of food or predators.
Hydrology	The study of the movement, distribution and quality of water.
IFN (Instream Flow Needs)	The amount of water required in a river to sustain a healthy aquatic ecosystem, and/or to meet human needs such as recreation, navigation, waste assimilation or aesthetics.
Inorganic	A substance of mineral origin, containing no carbon.

Glossary Cont.

Mainstem	For the purpose of this Interim Management Framework, the mainstem of the Muskeg River is defined as that portion of the Muskeg River from its mouth, entering the Athabasca River, extending upstream to the west boundary of Oil Sands lease 88 (ExxonMobil Canada), in Township 97-Range 8- W4M.
Metals	Elements that occur naturally in the earth's crust and are found in water, in either dissolved or particulate form. Many are essential for life, but excessive or deficient concentrations can be toxic. Metals can enter surface waters naturally through weathering and runoff from bedrock, but are also present in industrial and wastewater discharge.
Naphthenic Acids	Naturally occurring hydrocarbons found in surface waters in the Athabasca oil sands area. Oil sands process-affected water is toxic to aquatic organisms, and naphthenic acids are the primary group of compounds responsible for the toxicity.
Nitrite	A dissolved, inorganic form of nitrogen. In well-oxygenated water it is converted quickly to nitrate. High concentrations of nitrite can be toxic in drinking water.
Non-point Source Pollutant	A diffuse source of pollution that cannot be attributed to a clearly identifiable, physical location. It is difficult to quantify, highly variable and difficult to control. Examples include land runoff that enters aquatic systems, or pollutants dispersed into the air which can enter aquatic systems through deposition.
Nutrient	A substance taken up by organisms that promotes growth. In aquatic ecosystems, the most important nutrients are phosphorus and nitrogen.
Organic	A substance usually of animal or plant origin that contains carbon.
Peat	Soil composed of decaying organic matter, often found in water-saturated, high latitude areas.
pH	The concentration of hydrogen ions in the water (pH 7.0 is neutral; above 7 is basic, below 7 is acidic). At acidic pH concentrations metals such as aluminum and iron can become toxic.
Point Source Pollutant	A source of pollution that can be attributed to a specific physical location; an "end of pipe" source that is easy to identify, quantify and regulate. An example would be discharge from a wastewater treatment plant.

Glossary Cont.

Process-Affected Water	Any water that has come in contact with oil sands through an industrial process, and may contain hydrocarbons and other chemicals
Receptor	Components within an ecosystem that react to or are influenced by stressors.
Riparian Zone	The zone in which terrestrial plants grow adjacent to a stream, river, lake or wetland.
Runoff	Precipitation that flows over the ground into streams or lakes. Runoff can collect pollutants from the land and carry them to the receiving waters.
Seepage	The act or process of slowly entering, departing, or becoming gradually diffused.
Stressor or Disturbance	The physical, chemical or biological factors that affect an ecosystem. They can be an event or activity that is either above or below the natural level of disturbance, causing changes to the ecological components, patterns or processes of aquatic ecosystems. They can be natural events or the result of human development and activities.
Sustainable	A characteristic of an ecosystem that allows it to maintain its structure, functions and integrity over time and/or recover from disasters without human intervention.
Topography	The three-dimensional quality of the earth's surface with a focus on land elevation, physical features and landform patterns.
Total Dissolved Solids	The inorganic and organic salts dissolved in water. Principal components generally include the cations calcium, magnesium, sodium and potassium, and the anions carbonate, bicarbonate and sulphate.
Total Nitrogen	Nitrogen is an essential nutrient for productivity of the aquatic system. Total nitrogen is the sum of the different forms found naturally in water, including nitrate, nitrite and ammonia. Nitrogen enters surface waters naturally but in elevated concentrations can result in excessive growth of algae and aquatic plants.
Total Phosphorus	Phosphorus is a nutrient essential for aquatic plant growth. Total phosphorus is the sum of the different forms found naturally in water. Elevated concentrations can result in excessive growth of algae and aquatic plants.
Toxicity	The adverse effect on the growth, reproduction or survival of an organism.

Glossary Cont.

Water Quality Guideline	A numerical concentration or narrative statement recommended to support and maintain a designated water use. Designated water uses include protection of aquatic life, source water for drinking water, recreation, irrigation, industrial and aesthetics. The guideline for each category may be different.
Water Quality Limit	A point at which a designated water use may be impaired. These were established using generic water quality guidelines. By preventing a water quality parameter from exceeding its capacity limit, impacts on water uses may be prevented. Generic-based WQL may be superseded by reach specific water quality objectives when established for the river.
Water Quality Objective	A pollutant concentration, physical or chemical condition of the water designed to protect, in this report, aquatic life. The objective represents the maximum amount of pollutant or condition that can exist in the water without causing any adverse effect on aquatic life or beneficial use.
Water Quality Target	A point where a non-desirable shift in a water quality parameter has occurred. These are established using an anti-degradation (or keep water clean) approach. Targets are set for individual water quality parameters and can be established for various scenarios and environmental conditions, such as seasons, developmental stages of organisms, or climate change. By preventing a water quality parameter from exceeding its target, water quality can be maintained with no significant degradation.
Water Quantity Objective	The amount of water (flow in rivers, level in lakes) required to protect water uses. From an environmental Instream Flow Needs (IFN) perspective, these limits are defined in order to maintain the natural range of flows required for aquatic organisms, aquatic or riparian habitat, water quality and the physical, geomorphic processes of the aquatic system. Objectives are site-specific and based on local characteristics and natural seasonal variation inherent to the water body.
Water Yield	The discharge of river as a function of the land area it drains.

1 INTRODUCTION

1.1 Background and Context

The Muskeg River watershed is located in the Athabasca Oil Sands region of northern Alberta. The Muskeg River is a tributary of the Athabasca River, and drains an extensive area of boreal forest wetlands. The watershed is underlain by mineable oil sands, which have become an increasingly important part of Alberta's economy. The watershed is rapidly being developed to extract these resources, and a number of existing, planned and approved oil sands mining projects are underway. To ensure that the ecological integrity of the Muskeg River watershed is not compromised by this industrial activity, it is necessary to implement a strategy to appropriately manage the resources and environment.

Responding to concerns regarding the level of resource extraction and development within the Oil Sands region including the Muskeg River watershed, Alberta Environment (AENV), in collaboration with key stakeholders and Aboriginal communities, adopted the Regional Sustainable Development Strategy (RSDS) in 1999. The purpose of the RSDS was to address the cumulative environmental effects in the Athabasca oil sands region. Nine years later, with the possibility of previously unimagined development, the Government of Alberta is taking the lead in setting a new course for sustainable development and environmental management of regional cumulative impacts in the oil sands. This new direction will enable responsible resource development that incorporates creative and innovative solutions to secure economic prosperity while maintaining the province's commitment to environmental protection and stewardship.

A strong message has been sent to the Government of Alberta that managing the cumulative environmental effects must be a top priority, as noted in the Oil Sands Consultation: Multistakeholder Committee final report (June 30, 2007) and the Aboriginal consultation final report (June 30, 2007). Both reports reflect the views and input of stakeholders in establishing a vision and principles to guide the future development of Alberta's oil sands together with environmental management. One of the key recommended actions of these reports is to focus on cumulative effects management, integrated regional planning and comprehensive watershed management as means to minimize environmental impacts. The recommendations of both reports were adopted by the Government of Alberta in October 2007 and are now recognized by all ministries.

Recently, Premier Ed Stelmach has charged the Minister of Environment with specific mandates to *"ensure energy resources are developed in an environmentally sustainable*

way" and to *"manage Alberta's water resources to ensure the province has the quality and the quantity of water needed now and into the future to support population and economic growth".*

This Muskeg River Interim Management Framework is a starting point to achieve these regional goals in a management system that is expected to be iterative as it includes greater spatial and temporal perspective on the impacts influencing the regional environment. By leading the Muskeg River Interim Management Framework, the Government of Alberta is demonstrating its commitment to cumulative impact assessment and management. It is also consistent with the Alberta-Federal Joint Panel recommendations made following public hearings for the Shell Jackpine Mine (EUB decision 2004 - 009), the Muskeg River Mine Expansion (EUB decision 2006-128), and most recently the Kearl Oil Sands Project (EUB decision 2007-013). Joint Panel recommendations evolved over the course of these three project reviews eventually culminating in the panel recommended that *"AENV take immediate steps to ensure that the Muskeg River Water Management Plan is completed and approved on a priority basis and no later than September 2008. If CEMA fails to deliver the plan by this deadline, the Panel recommends that AENV implement a full backstop by the end of 2008."*

The Interim Management Framework fulfills what the Government of Alberta communicated at both the Muskeg River Mine Expansion and the Kearl Oil Sands Project hearings. The Government of Alberta indicated that pending the development of an integrated water management framework for the Muskeg River basin, *"AENV would consider other options for implementing comprehensive criteria that would influence development in the Muskeg River basin"* (EUB Decision 2007-013). Alberta Environment also noted that a "minimum" backstop would be considered for determining thresholds for water quantity and quality in the Muskeg River basin. The Joint Panel supports AENV's "considering interim measures until a watershed management plan for the Muskeg River basin is completed and accepted" (EUB Decision 2006-128).

In keeping with its legislative mandate, AENV has developed the Interim Management Framework for the Muskeg River with a focus on water quantity and water quality. This framework will be used by AENV to guide regulatory decisions until the end of 2009. AENV, in collaboration with First Nations and other stakeholders, will immediately initiate the comprehensive plan for the Muskeg River watershed and will target to complete by the end 2009. If the comprehensive plan is not completed by the end 2009, AENV will consider updating and revising the interim framework.

1.2 Interim Management Framework Definition

The Muskeg River Interim Management Framework is a structured approach to managing water quantity and quality within the Muskeg River watershed. It attempts to

balance development with environmental needs. It also takes an integrated approach to cumulative environmental impacts, managing multiple environmental stressors on the watershed (e.g., land disturbance, discharges to the environment). It acknowledges that establishing management goals for individual companies or industrial activities in isolation is not an appropriate method to manage cumulative impacts. Instead, it takes an outcome-oriented approach to the management of water quantity and quality.

The Interim Management Framework defines criteria for the evaluation of water quantity and quality. Observed conditions are compared against scientifically-established limits that are developed specifically for the Muskeg River watershed. These limits are based on data collected within the Muskeg River watershed, as well as more broad information on streamflow, water quality and the requirements of aquatic organisms. This approach follows the principle of maintaining environmental conditions as close to the natural state as possible.

The management of activities within the watershed must be responsive to the evaluation process. Therefore, the water quantity and quality limits established in this framework are associated with management actions. Compliance with the appropriate management actions will offset environmental impacts, reducing stresses on the ecosystem. Ongoing monitoring and follow up is required, including adjustments to the framework as necessary. Effective implementation of this Interim Management Framework will help to appropriately manage the Muskeg River watershed.

1.3 Legal and Regulatory Framework

The Interim Management Framework will meet its established management objectives and will result in positive outcomes only to its degree of integration within the existing legal and regulatory framework. As mentioned previously, water quality and water quantity are regulated respectively under the *Environmental Protection and Enhancement Act* (EPEA) and the *Water Act*, which are administered by AENV. In carrying out its mandate, AENV may establish limits, targets and management objectives for water quality and water quantity to protect aquatic resources. These limits, targets and management objectives are incorporated into the terms and conditions of the approvals and licences under the Acts. The approval holders are required to comply with these conditions and report to AENV.

It is currently expected that the Interim Management Framework will be largely implemented through terms and conditions in the EPEA and *Water Act* licences and approvals. Alberta Environment will have opportunities to impose requirements in the context of decision-making for new applications of approvals and licences, as well as through approval and licence amendment applications and renewals. If necessary, AENV will also use “Director-initiated” amendment authority (a “Director” is the

designated decision-maker under these acts). EPEA allows for Director-initiated amendments relating to monitoring or reporting requirements and to address adverse effects not reasonably foreseeable at the time of approval issuance (EPEA s. 70(3)(a)(i) and (ii)). The *Water Act* allows for amendments of licences relating to monitoring and reporting requirements and, generally, if there is a term or condition of the licence allowing the amendment (*Water Act* s. 54(1)(a)(iii) and (ix)). The *Water Act* also allows for amendment of approvals in circumstances including: in relation to monitoring, reporting or inspection requirements; to address significant adverse effects on the aquatic environment not reasonably foreseeable at the time the approval was issued; and, generally, if there is a term or condition of the approval allowing the amendment (Act s. 42(1)(a)(ii), (vi) and (viii)).

Table 1.1 below summarizes the existing EPEA and *Water Act* approvals and licences within the Muskeg River watershed.

Table 1.1 Existing EPEA and *Water Act* Approvals and Licences within the Muskeg River Watershed

Approval Holder / Project(s)	**Legislation**	**Approval / Licence Number**	**Date of Issue**	**Expiration Date**
Shell Jackpine Oil Sands – Phase 1	EPEA	153125-00-00	6-23-04	6-22-14
Muskeg River Oil Sands	EPEA	20809-01-00	11-8-07	11-01-17
Kearl Oil Sands	EPEA	46586-00-00	11-9-07	11-01-17
Mildred Lake\Aurora North and Aurora South	EPEA	26-02-00	6-24-07	6-23-17
Husky Oil Operations	EPEA	206355-00-00	10-31-06	10-30-2016
Birch Mountain Resources	EPEA	189942-00-00	7-21-05	7-20-2015
Shell Jackpine Oil Sands – Phase 1	*Water Act*	00186157-00-00	6-23-04	6-23-14
Muskeg River Oil Sands	*Water Act*	00071821-00-00	8-4-99	2-16-09
Kearl Oil Sands	*Water Act*	00222199-00-00	12-09-07	11-1-17
Aurora North	*Water Act*	00048398-00-00	11-28-97	12-15-09

AENV has taken a proactive approach, particularly for the recently approved projects, and has included the following condition in the EPEA approvals (Section 4.2.20):

> " the approval holder shall implement an interim monitoring plan or interim management framework prepared or provided by the Director related to the watershed integrity of the Muskeg River, to the satisfaction of the Director".

For the *Water Act* licences, the following condition was included:

> "This approval is based on the knowledge available at the time of issue and therefore is subject to review and modification. The Director reserves the right to amend the approval and/or require modifications to the works as deemed necessary".

2 OVERVIEW OF THE MUSKEG RIVER WATERSHED

The Muskeg River watershed is a tributary to the Athabasca River in the Regional Municipality of Wood Buffalo. It has a watershed area of about 1,480 km^2 (148,000 hectares) The mouth of the river, where it enters the Athabasca River, is located about 55 km north of Fort McMurray and about 5 km east of Fort MacKay. Figure 2.1 shows the extent of the Muskeg River watershed.

The watershed is located within the boreal forest. Its lowlands are covered with black spruce and tamarack muskeg, while the upland areas are treed with trembling aspen, white spruce and jackpine forests. There are several major tributaries to the Muskeg River, including Jackpine, Muskeg and Wapasu creeks. Kearl Lake is the largest lake within the watershed.

The Muskeg River is characterized as a brown water system. Beaver ponds are common throughout the watershed, and influence streamflows as well as water quality (McEachern and Noton 2002). The river provides important fish habitat for both resident and migrant populations. A total of 22 fish species have been recorded in the river, with white sucker, longnose sucker, lake chub and Arctic grayling the most common (AXYS 2005).

The Muskeg River watershed is undergoing rapid development. Currently, two producing oil sands mines and one limestone quarry are operating within the watershed. The oil sands mines are Syncrude's Aurora North Mine and Albian Sands Muskeg River Mine. Shell's Jackpine Mine Phase1 is currently under development. Birch Mountain's Muskeg River Valley Quarry currently mines limestone.

Several oil sands projects have recently been approved, but not yet developed, within the watershed. These projects include Albian Sands Muskeg River Mine Expansion, Syncrude's Aurora South Mine, Imperial Oil/Exxon/Mobil's Kearl Oil Sands Mine, and Husky's Sunrise Thermal Insitu Project. Shell has also initiated an application for their Jackpine Mine Phase II Expansion, as has Petro-Canada for its Fort Hills Project amendment. Table 2.1 lists the existing, approved and planned oil sand projects in the Muskeg River watershed.

These mining activities have the potential to disturb approximately 50 to 60% of the Muskeg River watershed area. Without careful planning and appropriate regulations, there are concerns that the cumulative effects of these large-scale and long-term developments could compromise the ecological integrity of the Muskeg River. This Interim Management Framework is one component in addressing these concerns.

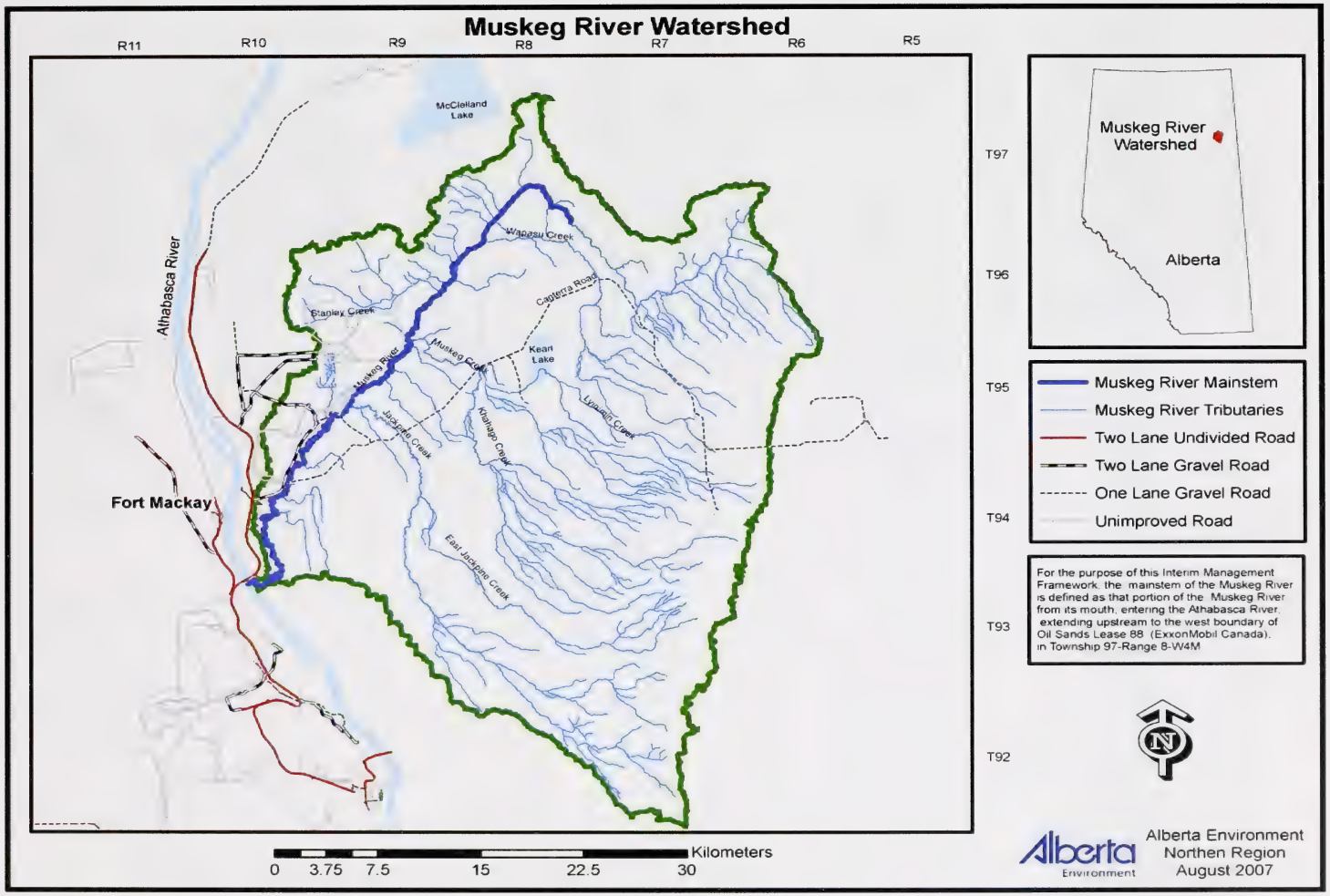

Figure 2.1 The Muskeg River Watershed

Table 2.1 Major Existing, Approved and Planned Development Projects in the Muskeg River Watershed

Company\Project Name	Status	Approval Date	Capacity	Land Disturbance (ha)[g]
Albian Oil Sands Muskeg River Mine	Existing/ Approved	1999	150,000 [a]	4,383
Albian Oil Sands Muskeg River Mine Expansion	Approved	2006	120,000 [a]	8,091
Shell Canada Limited Jackpine Mine – Phase 1	Approved	2004	200,000 [a]	8,154
Shell Canada Limited Jackpine Mine Expansion	Planned	2007 [e]	100,000 [a]	13,030
Imperial Oil Resources Kearl Oil Sands	Approved	2007	200,000 [a]	19,660
Syncrude Canada Aurora North	Existing/ Approved	1997 [f]	195,000 [a]	7,980
Syncrude Canada Aurora South	Approved	1997 [f]	195,000 [a]	8,966
Husky Energy [c] Sunrise Thermal Project	Approved	2007	200,000 [a]	534
Birch Mountain Resources [d] Muskeg Valley Quarry	Existing/ Approved	2005	6,900,000 [b]	1,500
Birch Mountain Resources Hammerstone Project	Planned	2006 [e]	24,400,000 [b]	

a barrels of bitumen production per day (bbl/d)
b tones of limestone per year
c Husky Sunrise is the only thermal project in the watershed and will use Steam Assisted Gravity Drainage (SAGD) to develop the resource. All other oil sands projects in the watershed are open pit truck and shovel mining.
d Birch Mountain Resources has received regulatory approval for its Muskeg Valley Quarry in 2005 and has recently filed an application for the Hammerstone project which includes a limestone processing facility.
e Application filed date
f ERCB approval date
g 1 km^2 = 100 ha

2.1 Water Quantity

The hydrology of the Muskeg River watershed is typical of other boreal forest systems. It is strongly influenced by the watershed's particular topography, soil characteristics and climate. These factors determine the amount of water present in the system and how it varies seasonally and annually (McEachern and Noton 2002).

The headwaters and mouth of the Muskeg River have a moderate grade (4.2 m/km and 3.5 m/km, respectively), while the remaining 60% of its length is relatively flat (less than 0.3 m/km). Both the upper and lower reaches of the river are dominated by peat soils which readily absorb snowmelt and precipitation. Water that infiltrates the soil travels downgrade until it reaches the river or one of its tributaries. However, the relatively low topographic relief and high soil permeability allow soils to store water, limiting what they discharge to the river (McEachern and Noton 2002).

Several seasonal events affect streamflow in the Muskeg River watershed, including spring snowmelt, summer thaw of the peatlands and winter ice cover. Peak streamflow usually occurs during the freshet or toward the end of a wet summer. Spring freshet occurs in late April and May, when up to 50% of the Muskeg River's flow is snowmelt. By June, most of the peatlands have thawed and have a greater capacity to absorb the remaining snowmelt. As a result, there is very little overland flow within the watershed, with the exception of freshet (McEachern and Noton 2002).

During much of the rest of the year, shallow groundwater is the main source of streamflow in the Muskeg River watershed. Groundwater in the basin is usually less than 3 m below the surface of the land, although during snowmelt, the ground can become almost completely saturated. In the summer, groundwater from the peat soils contributes up to 70% of the streamflow (McEachern and Noton 2002).

The mean annual water yield of the Muskeg River is estimated to be 89 mm, which corresponds to a mean annual discharge of 4.1 m^3/s.The highest mean monthly flow generally occurs in May, with the lowest in February. Data collected on the lower Muskeg River from 1974 to 2003 recorded the maximum daily flow of 66.1 m^3/s on May 9, 1985 and the minimum of 0.04 m^3/s on January 2, 1984 (AXYS 2005).The hydrograph of the lower Muskeg River is shown in Figure 5.1, with seasonal variation shown in Figure 5.2.

2.1.1 Kearl Lake

Kearl Lake is the largest lake in the Muskeg River watershed. It drains a 85.6 km^2 area, while the lake itself has an area of 5.6 km^2. Monitoring data collected between 1998 and 2000 showed that the lake level fluctuated by about 0.5 m during this period. The mean

water level is about 331 masl (Golder 2005). Other key hydrological parameters of Kearl Lake are shown in Table 5.1.

2.2 Water Quality

The water quality of the Muskeg River is influenced by several factors, including soil chemistry, channel morphology and seasonal factors (McEachern and Noton 2002). A summary of key water quality parameters is shown in Table 2.1.

The shallow groundwater and surface runoff sources of the Muskeg River flow through the watershed's extensive peatlands before entering the river. These organic soils contribute relatively high concentrations of minerals, coloured compounds, total organic carbon (TOC) and dissolved organic carbon (DOC) to the water, resulting in the brownish colour of the Muskeg River (McEachern and Noton 2002, AXYS 2005). The median pH value of the river ranges from 7.0 to 8.15 pH units. The median daily temperature ranges from -0.01 ºC in the winter to 19.33 ºC in the summer (AXYS 2005).

Channel characteristics, such as gradient, play an important role in the water quality of the Muskeg River. In steep reaches of the river (at the headwaters and the mouth), water flows quickly through the channel. Fast-flowing, turbid water contains higher dissolved oxygen (DO) concentrations and suspended sediment loads in comparison to slow-moving water. In the middle reaches of the river where the gradient is lower and beaver dams are present, water flows more slowly and suspended sediment is deposited. Aquatic plants are able to grow where the river's velocity slows, which leads to a higher biochemical oxygen demand (BOD). In the middle reaches of the river, sedimentation and plant growth are linked to lower nutrient (phosphorus and nitrogen), DOC and total suspended solids (TSS) concentrations. The increased decay of organic matter in the middle reaches leads to higher concentrations of ammonia and lower pH and DO levels (McEachern and Noton 2002).

Water quality in the Muskeg River changes significantly over the seasons. In the spring, snowmelt runs across the thawing ground surface and contributes directly to river discharge. The chemical composition of the meltwater is dilute and low in ions and minerals. As a result, the Muskeg River and its tributaries are also dilute during the spring freshet (McEachern and Noton 2002). In particular, levels of hardness, total alkalinity, total dissolved solids (TDS) and bicarbonate are lower in the spring and summer seasons compared to the fall and winter, when flows are lower (AXYS 2005). High spring discharge and storm events also alter water quality by flushing accumulated sediment from the streambed. Particulate materials, including organic carbon and metals, are transported downstream (McEachern and Noton 2002).

Nutrients such as total phosphorus (TP) and total nitrogen (TN) are relatively high in the Muskeg River, but have not changed significantly since the early 1970s. Levels of ammonia often peak in the winter but do not exceed water quality guidelines. In contrast, total nitrogen levels in the winter have been found to exceed water quality guidelines (AXYS 2005).

Alberta Environment's *Surface Water Quality Guidelines for Use in Alberta* defines a **Water Quality Guideline** as a numerical concentration or narrative statement recommended to support and maintain a designated water use". Designated water uses include protection of aquatic life, source water for drinking water, recreation, irrigation, industrial and aesthetics.

Unless otherwise noted, the water quality guidelines referred to in this document are those established for the protection of aquatic life.

Under current conditions, TSS concentrations are well below water quality guidelines. Trace organic pollutants, such as naphthenic acids and total phenolics, are rarely detected in the water (McEachern and Noton 2002).

There is concern that water quality may be adversely affected by current and future development in the Muskeg River watershed, particularly by seepage from industrial facilities and the drainage of peatlands. Peatland drainage may result in water quality guideline exceedances for mercury and iron, which are naturally found in high levels in the watershed's peat soils. Maximum concentrations of other metals (aluminum, copper, lead and zinc) have occasionally exceeded water quality guidelines in the Muskeg River (AXYS 2005). Other metals are detected at low concentrations. Low flows during the winter contribute to the elevation of some metals concentrations above water quality guidelines (McEachern and Noton 2002).

Water quality analyses indicate that currently, the Muskeg River is not sensitive to acidification. The river is well-buffered and has a high capacity to neutralize any future acidic deposition. The exception to this is during the spring runoff, when the conductivity and acid neutralizing capacity of the river decreases substantially as a result of dilution (WRS 2003). In addition, an unexplained decrease in pH from 7.8 to 7.3 pH units was documented in the Muskeg River between 1997 and 2001 and warrants further investigation (McEachern and Noton 2002).

The Muskeg River is generally well oxygenated throughout the year, but low DO concentrations occasionally occur during the winter (AXYS 2005). These low levels are due to low velocities and ice cover that prevents aeration of the water. Although low DO is not a significant problem under current conditions, the river is sensitive to conditions which increase oxygen demand. If river flows diminish in the future, DO values are likely to decline while BOD increases (McEachern and Noton 2002).

Table 2.2 Summary of Water Quality at the Mouth of the Muskeg River (1997 – 2003)

Water Quality Parameter	Units	Median	Range	Water Quality Guideline
Physical Parameters				
pH	pH Units	8.0	7.4 – 8.3	6.5 – 9.0
TSS	mg/L	3	3 – 70	-
Conductivity	µS/cm	359	220 – 671	-
Nutrients				
Total phosphorus	mg/L	0.022	0.008 – 0.072	0.05
Dissolved phosphorus	mg/L	0.014	0.005 – 0.030	0.05
Total nitrogen	mg/L	0.8	0.4 – 1.2	1.0
Nitrate+Nitrite	mg/L	0.1	0.05 – 0.1	-
Dissolved organic carbon	mg/L	21	15.7 – 24	-
Ions				
Sodium	mg/L	12	8 – 64	-
Chloride	mg/L	3	1 – 36	230 (continuous), 860 (maximum)
Sulphate	mg/L	8.3	3.5 – 91	100
TDS	mg/L	280	184 – 405	-
Total Alkalinity	mg/L	177	105 – 313	-
Organic Compounds				
Naphthenic acids	mg/L	<1	<1 - <1	-
Selected Metals				
Total aluminum	mg/L	0.090	0.027 – 1.2	0.100
Dissolved aluminum	mg/L	0.01	0.0025 – 0.03	0.100
Total boron	mg/L	0.042	0.032 – 0.15	1.2
Total molybdenum	mg/L	0.001	0.0001 – 0.0003	0.073
Total mercury	ng/L	<0.06	<0.06 - <0.06	26

Source: Hatfield *et al.* 2005

Notes: These values represent samples taken in the fall from 1997 to 2003.
The Water Quality Guideline values are CCME/AENV guidelines; exceptions are chloride, where the U.S. EPA value is used, and total boron, where the B.C. Working Water Quality Guideline is used.
There is no guideline specifically for dissolved phosphorus or dissolved aluminum; the guidelines noted are those for total phosphorus and total aluminum, respectively.

In summary, water quality parameters of potential concern in the Muskeg River may include low DO, decreasing pH and an increase in some total metals (e.g., aluminum, chromium, cadmium, copper, lead, iron and manganese). Total nitrogen and phosphorus concentrations may also be of potential concern, as well as total phenolics and naphthenic acids. Naphthenic acids are included in this list due to the uncertainty associated with their occurrence, fate and toxicity. Mercury could also be listed as a potential parameter of concern due to the lack of long term data with detection limits below water quality guidelines (AXYS 2005).

Overall, the data record indicates few changes in the water quality of the Muskeg River over time. The Regional Aquatics Monitoring Program (RAMP) results indicate that water quality did not change substantially between 1997 and 2004 (Hatfield *et al.* 2005. The exception to this is sulphate, concentrations of which were significantly higher during 1998 and 1999. The likely reason for this increase was drainage from the now decommissioned Alsands Drain (Golder 2003).

In addition, elevated levels of total phenols, TDS, sulphate, alkalinity and conductivity were found in Stanley Creek, a tributary of the Muskeg River, in 2003. These increases were attributed to the initiation of discharge into the creek by Syncrude Canada Ltd. in early 2003. Water quality reverted to previous values in 2004 following the rerouting of the discharge from the creek into ponds. These changes to Stanley Creek did not appear to affect the water quality of the Muskeg River. Overall, there has been little observable change in the water quality of the Muskeg River since 1996, when oil sands operations began operating within the watershed (Hatfield *et al.* 2005). Ongoing RAMP monitoring of water quality in the Muskeg River will help to determine any future changes within the watershed.

2.3 Key Issues and Concerns

The key environmental issues associated with resource development of the Muskeg River watershed have been documented in recent oil sands project applications, Environmental Impact Assessment (EIA) reports, Supplemental Information Requests and EIA Hearings. These impacts have economic, environmental, social and cultural aspects. The Interim Management Framework, however, will focus only on environmental issues as they pertain to water quantity and quality, as these are the issues for which AENV has legislative mandate.

The primary industrial activity occurring and planned within the Muskeg River watershed is oil sands mining. Oil sands activities can affect ecosystem structure and function through a variety of ways. These include physical disturbance and the release of point and non-point source pollutants. Environmental stressors associated with oil sands activities include, but are not limited to:

- Muskeg drainage and overburden dewatering
- Diversion and excavation of existing streams
- Construction of access roads and pipelines, including their crossings of streams
- Grading and excavation of land
- Mine pit dewatering
- Runoff and seepage from overburden disposal and reclaimed material storage areas
- Plant site runoff
- Seepage and runoff from tailings and sedimentation ponds
- Seepage, runoff and discharge from end pit lakes

Potential changes to environmental receptors as a result of exposure to oil sands activities and stressors include:

- Changes in channel forming processes
- Changes in the timing and intensity of streamflows
- Changes in basin sediment yield and nutrient concentrations
- Changes in suspended sediment concentrations
- Changes in water chemistry, including contaminants
- Lost connectivity between tributaries and the main channel
- Lost connectivity between Kearl Lake and its drainage basin
- Changes to the water level of Kearl Lake

Changes in these physical and chemical characteristics can lead to subsequent changes in or disruption to:

- Aquatic habitat, including riparian areas
- Abundance, growth and survival of aquatic organisms

- The ecological and hydrological significance of the Muskeg River to the lower Athabasca River

This Interim Management Framework is part of the effective planning and integrated management for resource development within the watershed. Implementation of the framework aims to reduce the near, medium and long-term impacts of resource development in the Muskeg River watershed to acceptable levels of change.

3 PURPOSE

3.1 Scope

The purpose of the Interim Management Framework is to guide AENV's regulatory decision making within the Muskeg River watershed. Specifically, it will address environmental effects assessment and monitoring of projects currently approved for the watershed. The framework, initially focused on water quality and quantity, will be in place until the end of 2009.

The Interim Management Framework focuses on developing limits to protect and manage the water quality and quantity of the Muskeg River watershed. Planning and management decisions will also be evaluated within the context of the Muskeg River as a key component of the Athabasca River aquatic ecosystem. Alberta Environment acknowledges that other terrestrial and land use components are important for the integrity of the watershed. These components, as well as economic and social/cultural considerations, will be addressed in the comprehensive management plan for the Muskeg River Watershed.

The Interim Management Framework focuses on water quality and quantity for two reasons. First, AENV and DFO jointly released a water management framework for the lower Athabasca River, making the management of regional tributaries a priority. Alberta Environment has a regulatory and legislative mandate under the *Environmental Protection and Enhancement Act* (EPEA) to manage all aspects of environmental quality and under the *Water Act* to specifically manage water quantity. However, many terrestrial and wildlife considerations will require a larger approach from the Government of Alberta.

Second, the basis of the Interim Management Framework is that the water quantity and quality of the Muskeg River are driving forces of the watershed. Changes to water quantity and quality have ecosystem-level ramifications, including impacts on habitat and aquatic and terrestrial populations. By appropriately managing and protecting water quantity and quality, the structure and function of the aquatic ecosystem as a whole should remain intact.

3.2 Outcomes

The Interim Management Framework has established management objectives and limits for water quantity and quality, as per the scope of the *Water Act* and the *Environmental Protection Enhancement Act*. Alberta Environment will lead the development of the comprehensive management plan for the Muskeg River Watershed.

The specific objectives of the Interim Management Framework were to develop:

- Water Quantity Objectives for the Muskeg River and Kearl Lake that protect water quality, aquatic habitat and organisms
- Water Quality Targets and Limits to protect and maintain the physical, chemical and biological characteristics of the Muskeg River
- A monitoring strategy to evaluate the impacts of development and manage and/or reduce those impacts
- An approach and information system that will assist the development of the Muskeg River Water Management Plan

A **Water Quantity Objective** is the amount of water (flow in rivers, level in lakes) required to protect water uses. From an environmental Instream Flow Needs (IFN) perspective, these limits are defined in order to maintain the natural range of flows required for aquatic organisms, aquatic or riparian habitat, water quality and the physical geomorphic processes of the aquatic system. Objectives are site-specific and based on local characteristics and the natural seasonal variation of the water body.

A **Water Quality Objective** is pollutant concentration, physical or chemical condition of the water designed to protect in this case, aquatic life. The objective represents the maximum amount of pollutant or condition that can remain in the water without causing any adverse effect on aquatic life or beneficial use.

A **Water Quality Target** is a point where a non-desirable shift in a water quality parameter has occurred. Alberta Environment calls these Investigation Level Thresholds (ILTs), which are established using an "anti-degradation" (or keep water clean) approach. Targets are set for individual water quality parameters and can be established for various scenarios and environmental conditions, such as seasons, developmental stages of organisms, or climate change. By preventing a water quality parameter from exceeding its target, water quality can be maintained with no significant degradation.

A **Water Quality Limit** is a point beyond which a designated water use may be impaired. AENV calls these Effects Level Thresholds (ELTs), which are established under a "use-protection" perspective, using water quality guidelines. By preventing a water quality parameter from exceeding its capacity limit, impacts on water uses may be prevented.

These outcomes of the Interim Management Framework are consistent with the directions of Alberta's *Water for Life* Strategy. Note that some changes in terminology have occurred since the development of the Watershed Framework Project Outline. These changes were made in order to reduce jargon and increase clarity. Despite these differences in terminology, no changes to the approach, intent or outcomes of the Interim Management Framework have been made.

3.3 Aboriginal Communities and Stakeholder Consultation

As outlined in the Provincial *Water for Life* Strategy, public consultation is essential for watershed planning. During the planning process for the Interim Management Framework, both Aboriginal communities and other stakeholders were given opportunities to understand the issues and challenges and provide input regarding preferred solutions and options.

Alberta Environment recognizes it has a duty to consult with First Nations where land management and resource development have the potential to adversely impact First Nations' Rights and Traditional Uses of Crown lands. Alberta Environment has committed to consult with First Nations on this Interim Management Framework. Alberta Environment has also consult with other key stakeholders that express interest in being part of the consultation process.

4 APPROACH

The Interim Management Framework is based on a combination of anti-degradation and effects-based limits. It includes an adaptive management component, incorporating Water Quantity Objectives and Water Quality Targets and Limits. This approach is described in more detail in the sections below.

4.1 Outcome Based Approach

Alberta Environment has recently adopted a new approach to address the cumulative effects on the environment. This approach attempts to balance economic growth with environmental protection. The management approach integrates the cumulative impacts of development on air, water, land and biodiversity. The purpose of this new approach is to guide environmentally responsible development by establishing socially acceptable, economically feasible and environmentally sustainable limits, targets and outcomes. These management actions are then incorporated into the regulatory process. The new approach represents a shift from the traditional "project-based" environmental protection to a holistic and collaborative management perspective. The new approach has been recently applied in the Industrial Heartland to protect the air, land and water of Edmonton's Capital Region.

The Interim Management Framework is an important first step toward addressing the cumulative effects of development on the Muskeg River watershed. The Interim Management Framework establishes limits and targets for water quality and water quantity pending the development of an integrated management plan for the entire watershed. The interim water quality and water quantity limits and targets could be revised in the future under consideration of social and economic values and interests of local communities and stakeholders.

4.2 Analytical Methods

The monitoring, assessment and management of a watershed falls into three linked categories:

- **Water Quantity:** The physical characteristics of water flow, including its volume and timing. Appropriate management of water quantity can ensure suitable water quality (through sufficient dilution) and habitat for aquatic organisms.

- **Water Quality:** The mass load and concentration of chemical constituents in the water, both suspended and dissolved. Appropriate management of water quality ensures protection of aquatic habitat and other uses (drinking, recreation, industry etc.).

- **Aquatic Health:** The general status of aquatic organisms. This can be measured through population level characteristics such as density, diversity, recruitment (birth/colonization, immigration rates) and mortality. Aquatic health is more difficult to monitor and assess than water quantity and quality, but provides a litmus test for how well quantity and quality are being managed.

As mentioned, the Interim Management Framework currently focuses on the appropriate management of water quantity and quality of the Muskeg River watershed. The Water Quantity Objectives and Water Quality Targets and Limits are derived from a scientific understanding of aquatic ecosystems and their capacity to tolerate disturbance and assimilate external stressors. Water quality and quantity monitoring data collected along the Muskeg River will be used as indicators of the effects of development in the watershed as a whole. Ongoing monitoring provides an assurance that the impact predictions made under the oil sands projects' EIAs are based on valid assumptions.

Water quantity and quality objectives and targets are good surrogates for monitoring ecosystem health. Assessing changes in water quantity and quality is therefore a powerful tool for identifying changes to other ecosystem components. Alberta Environment recognizes that this is not a complete approach. A comprehensive approach would also include aquatic organisms which are integrators of cumulative environmental effects. However, their response to the net result of changes could prove difficult to interpret, especially when the changes have a synergistic effect on the organisms. A comprehensive monitoring and management plan will address the effects that change in environmental components will have on the aquatic communities. Meanwhile, AENV has provided the best available approach for defining thresholds that can be determined with existing data and managed with certainty in time and location.

4.3 Baseline Data Review

There is a significant amount of existing baseline information and data for the Muskeg River watershed. This is primarily available through recent oil sands project EIAs and monitoring reports, through AENV at its long-term river monitoring stations, and through RAMP. An extensive volume of information has been gathered by CEMA and will be used to support the development of the comprehensive management plan. This available information was consolidated and used to develop the Interim Management Framework.

4.4 Establishing Thresholds and Management Conditions

In setting Water Quantity Objectives and Water Quality Targets and Limits for the Muskeg River, the Interim Management Framework has used existing information on streamflow, water quality and biotic requirements. From these data, minimum water quantity and quality thresholds were established. These thresholds are associated with management actions to offset the human and industrial impacts on water use. Figure 4.1 shows the scale of responses and management actions, depending on the current environmental conditions in relation to the established thresholds.

The Water Quantity Objectives translate into combinations of river flow (quantity of water in the river) and discharge limits for the maintenance of water quality. Water Quality Targets and Limits have been defined from a "keep water clean" perspective and a "use-protection" perspective, respectively. Keep water clean (anti-degradation) targets, or Water Quality Targets (WQTs), were based on that point at which contaminants increase in the river by more than 20% of the mean and peak values. Use-protection limits, or Water Quality Limits (WQLs) were based on existing Alberta, Canada and United States water quality guidelines, as specified in existing Alberta policy.

The Interim Management Framework consists of three environmental management conditions for both water quantity and quality. These conditions correspond to reductions in the environmental capacity as flows decline and pollutant concentrations increase. The three environmental management conditions are colour coded as:

- **Green:** Cumulative impacts from development on flows and water quality have no measurable negative impact on management goals for ecosystem integrity; the aquatic system is in near-background state. No management actions or responses are required.

- **Yellow:** Negative impacts to the aquatic system are resulting in its shift away from the management goals for ecosystem integrity. As a result, sources of these impacts, as well as trends and risks must be evaluated. Management activities are invoked where possible. Enhanced monitoring and risk management plans are required and shared management activities to improve conditions are promoted.

- **Red:** Impacts to the aquatic system exceed limits for ecosystem integrity, and require a management response. Red conditions (low flow based) for water quantity require mandatory adherence to cumulative loss limits. The exceedance of Water Quality Limits for a certain parameter requires mandatory reductions in that parameter load.

Water quality is managed based on many chemical parameters in the water while quantity is managed based on flow expectations for each week. Individual investigation and water quality objective triggers exist for each parameter that enters the river (e.g. nutrients, metals and industrial chemicals) with management actions for these triggers as shown in the figure below.

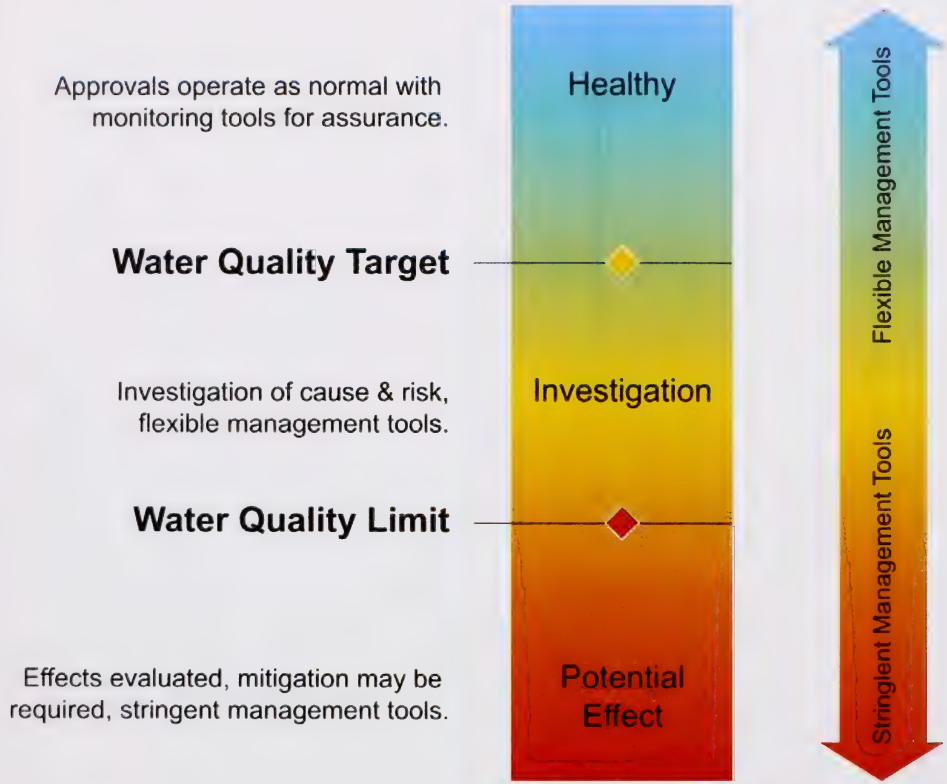
Approvals operate as normal with monitoring tools for assurance.
Healthy
Water Quality Target
Investigation of cause & risk, flexible management tools.
Investigation
Water Quality Limit
Effects evaluated, mitigation may be required, stringent management tools.
Potential Effect
Flexible Management Tools
Stringent Management Tools

Figure 4.1 Scale of Responses to Environmental Management Conditions

4.4.1 Water Quantity

A river environment is shaped by the range of flows it historically experienced. An accepted management approach is to maintain this historic pattern of flows as closely as possible. Water Quantity Objectives can therefore be established on a weekly basis to match the variability of flows that naturally occur.

Current instream flow science recommends that a minimum of 85% of instantaneous flow is required to support aquatic life under most flow conditions (15% is allowed for use). These are designated as green conditions. Increasing restrictions are required during dry periods, which are designated as yellow or red conditions, depending on the degree of low flow conditions. The yellow threshold is approximated by the Q80 streamflow, while the red threshold is approximated by the Q95 streamflow. This approach is consistent with the joint AENV-DFO Watershed Management Framework for the lower Athabasca River.

Q80: A naturally low streamflow where 80% of observed flows are greater than this value. The value is similar to the 20th Percentile.

Q95: A naturally very low streamflow where 95% of observed flows are greater than this value. The value is similar to the 5th Percentile.

4.4.2 Water Quality

Water quality of the Muskeg River watershed may be degraded by ongoing development within the basin. A review of site and overburden drainage, tailings pond waters and other potential source waters from existing oil sands mine operations indicates that significant loading of some substances to the Muskeg River could occur. Tools used in the Interim Management Framework define how much more loading is acceptable to ensure that the Water Quality Targets and Limits are not exceeded.

Yellow Water Quality Targets and red Water Quality Limits were based on monitoring data collected from approximately 100 key water quality parameters. These parameters include metals, toxic organic compounds, and non-toxic but ecosystem altering nutrients. Models calibrated to background upstream and downstream concentrations in the Muskeg River were used to develop these capacity limits.

Targets and Limits were established for both chronic (mean) and acute (peak) conditions. Each water quality parameter therefore has as many as four thresholds: a chronic and acute threshold for both the yellow and the red conditions. In this Interim Management Framework, the yellow Water Quality Targets (WQT) instigate an investigative action and are therefore meant to guide management actions for

evaluation and improvement where possible while the red Water Quality Limits (WQL) are considered to represent potential effects levels and management actions are stringent and mandatory. Appropriate mitigation is required if WQL are exceeded.

Acute Toxicity: Adverse effects on the survival of an organism that occur within a short time following exposure to a chemical.

Chronic Toxicity: Adverse effects on an organism that occur over the long term following exposure to a chemical. Behaviour, growth and reproduction of the organism may be affected.

A comprehensive and integrated water quality monitoring program from the upper watershed to the mouth of the river is being developed. The results of this monitoring program will be reviewed as part of the approach to ensure Water Quality Targets and Limits are appropriate and not exceeded.

5 ENVIRONMENTAL MANAGEMENT OUTCOMES

5.1 Water Quantity Objectives

Water Quantity Objectives establish the basic flow requirements that will protect an aquatic ecosystem from degradation. Natural streamflows fluctuate in magnitude, duration, frequency and timing both spatially and temporally. This regime alters the stream environment and provides aquatic habitat, sediment transport and water quality to support diverse plant and wildlife communities. Understanding the relationship between ecological function and natural streamflows can lead to more effective watershed management and minimize the environmental impacts of development.

This document defines streamflow objectives for the Muskeg River that will maintain the biologically significant components of the flow regime. The objectives were designed to mimic ecologically significant events of a natural hydrograph. Ideally, pre-development, current and proposed flow regimes of the Muskeg River should be modeled to develop flow recommendations. An alternative approach, and the one used here, is to use a "desktop'" or "spreadsheet" method. This method is simple, quick, inexpensive and has been adapted for Alberta conditions. It assumes that a certain percentage of normal flow is sufficient to protect the aquatic ecosystem. This technique produces a minimum flow that is calculated as a percentage of historical median flows. The minimum flow regimes are based on 33 years of data from the Muskeg River (1974 to 2006). However, only the first 15 of these years have winter flow data.

5.1.1 Natural Flow Regime of the Muskeg River

Figure 5.1 shows the historic streamflow of the Muskeg River, including the median, Q80 and Q95 flows. These are the natural flows of the Muskeg River, as there are presently no withdrawals from the river (very late in the process of developing this interim framework, Shell Canada submitted an application for approval of the Jackpine Mine Expansion, which includes a proposal to mine the upper reaches of the mainstem of Muskeg River). The yellow condition is approximated by the Q80 flows, while the red condition is approximated by the Q95 flows. The location of this gauging station is on the lower Muskeg River at the Water Survey of Canada gauge, as shown in Figure 5.3.

The historic streamflow diagram indicates that the Muskeg River has a fairly typical snowmelt pattern. Streamflow peaks in late spring due to snowmelt entering the river, with precipitation events causing smaller peaks in the fall. The annual median daily flow for the Muskeg River is 2.01 m^3/s and the annual mean flow is 4.3 m^3/s. The spring

median high flow is approximately 9.0 m^3/s, while the fall median high flow is around 4.0 m^3/s.

Mean: The average value in a group of numbers. It is the sum of all the values in that group divided by the number of values.

Median: The middle value in a group of numbers that are sorted in ascending or descending order. Half the numbers in this group are above the median value and half are below the median value.

Q80: A low streamflow value where 80% of observed flows are greater than this value. The value is similar to the 20th Percentile. Yellow conditions have been established as the flows below the Q80 but above the Q95.

Q95: A very low streamflow value where 95% of observed flows are greater than this value. The value is similar to the 5th Percentile. Red conditions have been established as the flows below the Q95.

Figure 5.2 demonstrates the cyclical pattern of the hydrograph over time (1974 to 2006). In addition to these seasonal flow conditions, the extreme water conditions of the Muskeg River are shown in this graph. The five ecologically significant flow conditions shown in Figure 5.2 are: low flows, extreme low flows, high flows, small flows and large floods. These repeating flow conditions must be maintained in order to sustain the ecological integrity of the river. While it is essential to maintain adequate flows during low flow periods, the higher flows and floods and extreme low flow conditions must also remain. These natural extremes in the flow pattern perform important ecological functions.

A preliminary water availability analysis has been conducted. This analysis has evaluated the potential for the Muskeg River flows to meet basic ecological flow needs in conjunction with the potential for water withdrawals that reduce flows in the Muskeg River. Currently, there are no water withdrawals in the Muskeg River. In the future, however, water withdrawals could occur, resulting in decreased flows when compared to natural conditions. Regardless, oil sands development is expected to impact flows of the Muskeg River, with a potentially more variable hydrologic regime expected during initial phases of development and lower variability as reclamation features such as pit lakes are completed. Higher average winter flows and lower average summer flows are expected. Development (and in particular the creation of lakes) will result in a beneficial increase in winter flows but at a cost to high flows during spring. Development will have substantial negative effects on flows in tributaries to the Muskeg River.

Figure 5.1 Natural Flows and Environmental Management Conditions of the Muskeg River

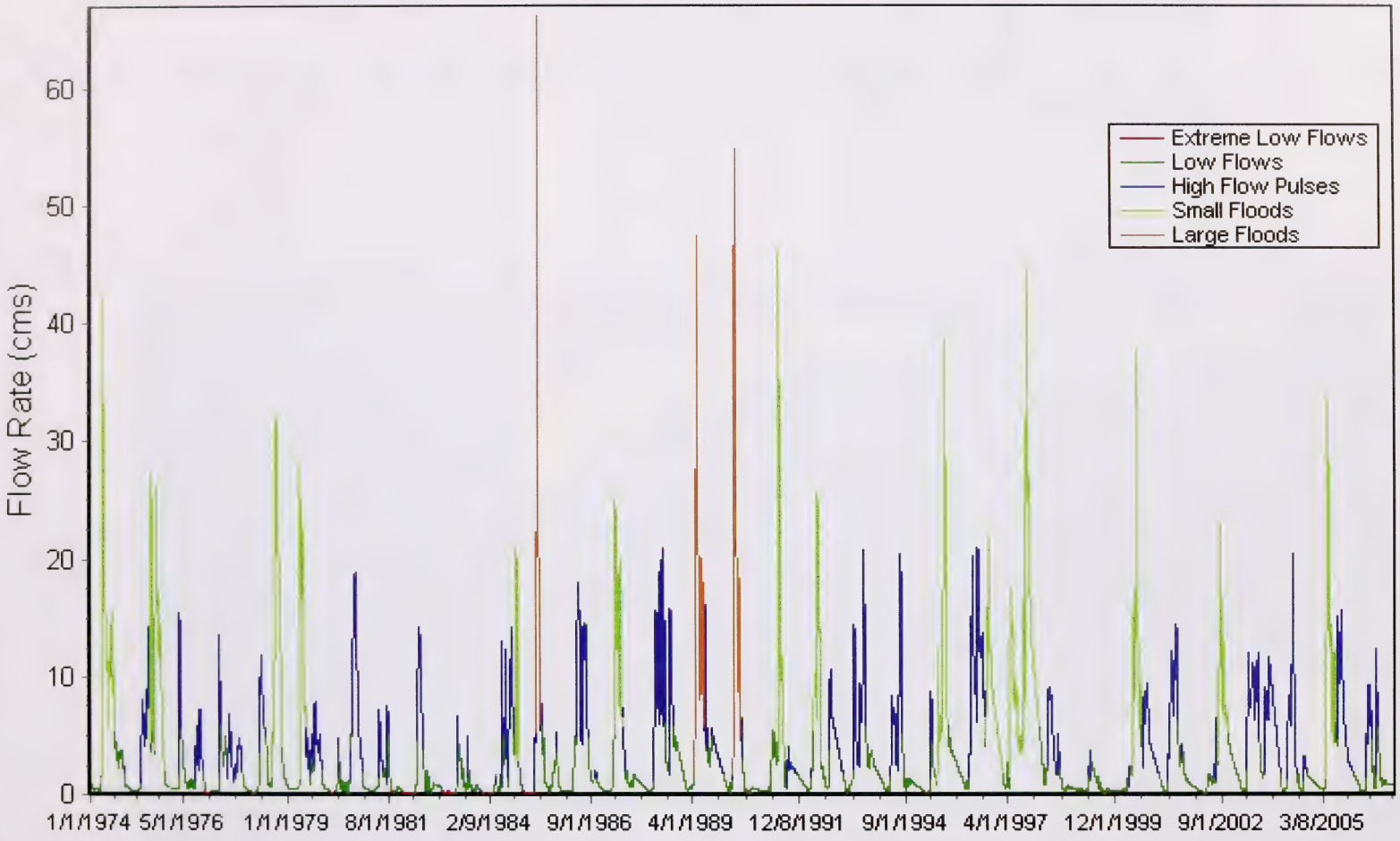

Figure 5.2 Ecologically Significant Flow Conditions in the Muskeg River (1974 - 2006)

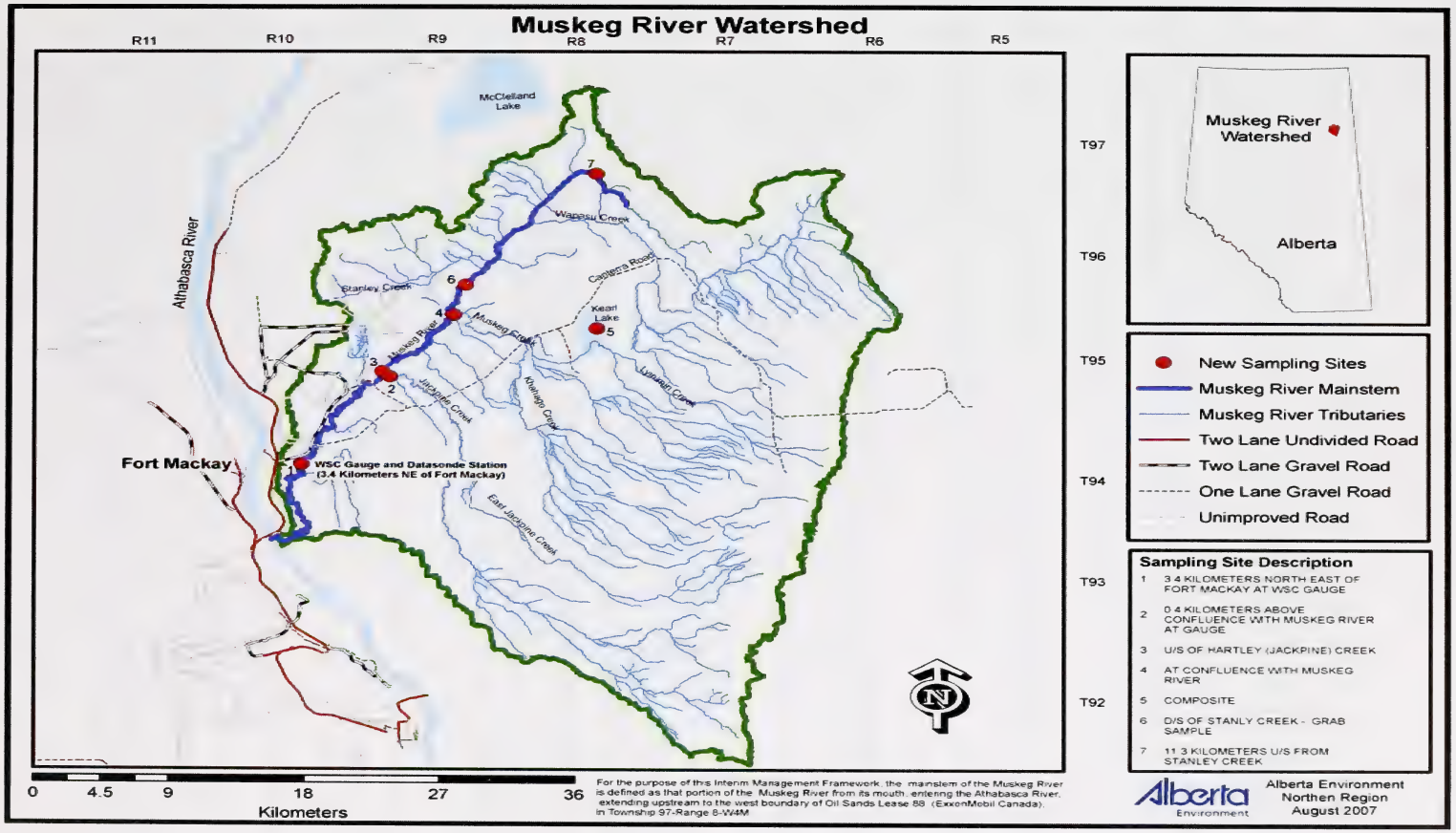

Figure 5.3 Streamflow and Water Quality Monitoring Stations within the Muskeg River watershed

5.1.2 Muskeg River Water Quantity Objectives

There is a potential for significant modifications to streamflow in the Muskeg River watershed. Winter flows may increase and peak flows may be reduced due to the existence of large lakes and other stabilization basins. Therefore, the framework considers open water and ice cover conditions differently with respect to changes in flow. The framework also considers reductions in flow more stringently than increases, with the exception of increases in peak flow. The following water quantity goals are proposed in view of current and future industrial developments:

- Maintain open water flow conditions such that the quality of aquatic habitat remains unchanged or improves
- Maintain an appropriate frequency of high flow events to maintain or improve aquatic habitat
- Maintain wet and dry conditions on river edge for riparian, fish spawning and invertebrate considerations
- Maintain sufficient water to ensure maintenance of water quality thresholds (Section 5.2)
- Ensure no physical diversion or re-routing of the mainstem of the Muskeg River while the Interim Management Framework is in place. However, AENV acknowledges that very late in the process of developing this interim framework, Shell Canada submitted an application for approval of the Jackpine Mine Expansion. This application includes a proposal to mine the upper reaches of the mainstem of the Muskeg River. The interim framework has not attempted directly to deal with this proposal at this time. AENV recommends that the decision on this application be guided by the public interest, considering economic, social and environmental values.

The following Water Quantity Objectives are evaluated at the Water Survey of Canada gauge site. They are based on the flow frequency distribution for each week of the year, with the management conditions shown in Figure 5.1:

- **Green:** Only 15% of the instantaneous flow is available for consumptive use in any week, should withdrawals occur. If watershed modifications result in increases in flow, the increases for the mean, median and peak flow statistics are expected to remain within 15% during the open water season. Winter increases in flow are not specifically constrained, however they must not increase the variability of flow (as measured by the coefficient of variation) and must conform with the maintenance of water quality objectives.

- **Yellow:** Only 5% of flow is available for consumptive use, should withdrawals occur. Increased flows as a result of watershed activities cannot exceed the historic median flow for that week if flows naturally would have been in yellow conditions.

- **Red:** No water is available for consumptive use or other withdrawals. Increased flows as a result of watershed activities cannot exceed the historic median flow for that week if flows naturally would have been in red conditions.

Peak flows sufficient to maintain the physical habitat of the Muskeg River must be maintained. This framework suggests that the 1 in 5 year flood flows remain at no less than a ten year statistical return interval. Alberta Environment expects that the Muskeg River Water Management Plan will conduct further work on this and other habitat-based requirements noted above.

Changes to water quantity in the Muskeg River must be accounted for when considering water availability in the Athabasca River. Increases or decreases in weekly flows will influence the assessment of water availability in the Athabasca River. The flows recorded at the Water Survey of Canada gauge site are added to Athabasca River flows when calculating its in-stream flow condition.

5.1.3 Kearl Lake Water Level Objectives

Kearl Lake is an important feature in the Muskeg River watershed. The lake has a relatively large surface area but relatively small water volume and low mean depth. Its key hydrologic parameters are outlined in Tables 5.1 and 5.2. This lake is likely very sensitive to declines in water level. Even a small decrease in the water level could result in ecosystem-level changes. An increase in rooted plant growth could occur, which may lead to a rapid transition from a lake to a wetland. Conversely, increased lake depth would likely improve its ecological functioning, as it could reduce the occurrence of winter fish kills due to low oxygen. However, prolonged flooding or increases in water level may negatively impact the wetland plants surrounding Kearl Lake and the mobilization of reduced chemical species.

Table 5.1 Key Hydrologic Parameters of Kearl Lake

Parameter	Value
Mean lake water level	331.94 m
Mean annual precipitation onto lake surface	435 mm
Mean annual lake surface evaporation	595 mm
Mean annual basin inflow	0.28 m^3/s
Mean annual lake outflow	0.25 m^3/s
10-year flood lake inflow	8.8 m^3/s
7Q10 low lake inflow	0 m^3/s

7Q10: The lowest streamflow for seven consecutive days that would be expected to occur once in ten years.

The Water Level Objectives for Kearl Lake are to maintain historic water levels, with management favouring a slight increase over a decrease. Water level objectives were based on a water balance model presented in Imperial Oil's Kearl Oil Sands Project EIA. The 10^{th} percentile low water level was chosen as a minimum, the long-term average as the management target and the 99.91 percentile as the maximum objective. Water levels in Kearl Lake will be managed to the target water level, which may fluctuate within reasonable frequency between the minimum and maximum water levels.

The Water Level Objectives for Kearl Lake are:

- Target water level: 331.94 masl
- Minimum water level: 331.71 masl
- Maximum water level: 332.29 masl

Table 5.2 Current and Predicted Future Kearl Lake Levels and Depths

Year	Parameter	Pre-Development					EAC									
							Mean Open-water		Mean Ice-Cover		10th Percentile		Median		90th Percentile	
		Mean Open-Water	Mean Ice-Cover	10th Percentile	Median	90th Percentile	Water Level/Depth	Change	Water Level/Depth	Change	Water Level/Depth	Change	Water Level/Depth	Change	Water Level/Depth	Change
2007	Water level (m)	331.08	330.99	330.91	331.02	331.21	331.08	0.00	330.99	0.01	330.92	0.01	331.02	0.00	331.21	0.00
	Maximum depth (m)	2.58	2.49	2.41	2.52	2.71	2.58	0.00	2.49	0.01	2.42	0.01	2.52	0.00	2.71	0.00
2044	Water level (m)	331.08	330.99	330.91	331.02	331.21	331.05	-0.03	330.98	-0.01	330.90	-0.01	331.02	0.00	331.17	-0.04
	Maximum depth (m)	2.58	2.49	2.41	2.52	2.71	2.55	-0.03	2.48	-0.01	2.39	-0.02	2.52	0.00	2.67	-0.04
2065	Water level (m)	331.08	330.99	330.91	331.02	331.21	331.10	0.02	331.00	0.01	330.91	0.00	331.03	0.01	331.24	0.03
	Maximum depth (m)	2.58	2.49	2.41	2.52	2.71	2.60	0.02	2.50	0.01	2.41	0.00	2.53	0.01	2.73	0.03
Far-Future	Water level (m)	331.08	330.99	330.91	331.02	331.21	331.10	0.02	331.00	0.01	330.91	0.00	331.03	0.01	331.24	0.03
	Maximum depth (m)	2.58	2.49	2.41	2.52	2.71	2.60	0.02	2.50	0.01	2.41	0.00	2.53	0.01	2.73	0.03

Pre-Development: current environmental conditions
EAC (Existing and Approved Case): Future environmental conditions predicted to occur following the construction and operation of all known oil sands developments within the Muskeg River watershed.

Source: Imperial Oil Kearl Oil Sands Project (2005).

5.2 Water Quality Targets and Limits

The multi-step process for establishing Water Quality Targets and Limits in the Muskeg River is summarized in Figure 5.4 and detailed below:

- **Water Quality Targets (WQTs):** established through the use of background concentrations, following an anti-degradation approach
- **Water Quality Limits (WQLs):** established through the adoption of generic guidelines (including existing guidelines and inter-jurisdictional guidelines), following a use-protection approach

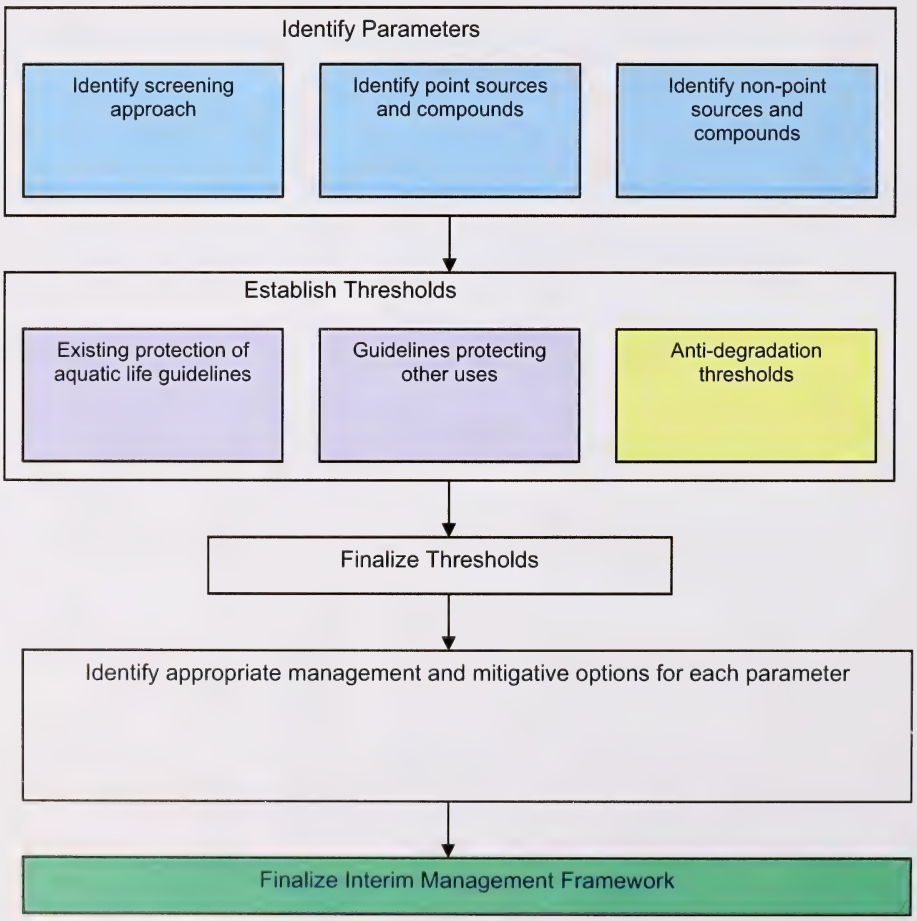
Identify Parameters
Identify screening approach
Identify point sources and compounds
Identify non-point sources and compounds
Establish Thresholds
Existing protection of aquatic life guidelines
Guidelines protecting other uses
Anti-degradation thresholds
Finalize Thresholds
Identify appropriate management and mitigative options for each parameter
Finalize Interim Management Framework

Figure 5.4 Steps to Establish Water Quality Targets and Limits for the Muskeg River

5.2.1 Parameter Selection

The first step in determining Water Quality Targets and Limits consistent with Figure 5.4 is to select parameters that are sensitive to environmental change within the watershed. These parameters must also be manageable. The parameters were selected using the following criteria:

- Loadings of the parameter could occur due to development activities
- The concentration of the parameter in the potential sources is at least two times greater than background concentration
- The parameter is consistently detected in potential source waters when more than 50% of the background concentrations of the parameter are non-detectable

Significant loadings to the Muskeg River could occur in the future as the oil sands developments progress (see Figure 5.5). Compounds that are predicted to be present in the oil sands mine site drainage or potential release waters were automatically considered as parameters for management thresholds and screened as above. As new parameters are identified (for example, from future monitoring or modelling results), they will be assessed in the same way. The Interim Management Framework will be amended to include them, as necessary.

5.2.2 Establishing Targets and Limits

Water Quality Targets and Limits were established for the yellow and red environmental conditions within the Muskeg River. A yellow Water Quality Target (WQT) and a red Water Quality Limit (WQL) were defined for each selected parameter for both chronic (mean) and acute (peak) conditions. Table 5.3 lists the parameters and their respective targets and limits. Appendix A provides more detail on how these WQTs and WQLs were established.

5.2.2.1 Water Quality Targets (WQTs) (Yellow Condition)

The yellow condition, or WQTs, for each parameter was based on an anti-degradation approach. Anti-degradation approaches are common in water quality management. The intent is to protect existing uses and maintain near-pristine water quality. WQTs were defined based on historic water quality data collected from within the Muskeg River watershed, which represent background conditions. Descriptive statistics were calculated for each parameter. The WQTs were then determined by considering frequency, duration and magnitude.

The WQT was set by applying an incremental increase in each parameter compared to background conditions. The incremental increase varied for different classes of compounds, with increasing restrictions occurring with increasing known or suspected toxicity. An increase of more than 20% of mean and peak background concentrations for pollutants was considered to approach changes in the Muskeg River that exceed anti-degradation expectations.

5.2.2.2 Water Quality Limits (WQLs) (Red Condition)

Effects-based criteria formed the basis for defining the red management zone, or WQLs. In general, existing Albertan, Canadian and international water quality guidelines for the protection of aquatic life were used to establish the Limits. Exceptions to this occurred under the following circumstances:

- Absence of a guideline where adverse effect could occur
- Guideline is lower than background concentration
- Adequacy (site specific factors) of existing guideline
- Guideline is more than 10 times the background concentration

Table 5.3 Water Quality Targets and Limits for the Muskeg River

Water Quality Parameter	Units	WQT Mean Target (Yellow)	WQT Peak Target (Yellow)	WQL Mean Limit (Red)	WQL Peak Limit (Red)
General Chemistry and Nutrients					
Temperature	°C	10.6	25.3	RSWQO	RSWQO
Chlorophyll a	mg/m^3	5	12	NA	NA
Total Kjeldahl Nitrogen	mg/L	1.300	3.500	RSWQO	NA
Nitrate + Nitrite	mg/L	0.030	0.362	RSWQO	29
Ammonia	mg/L	0.179	0.718	0.5	2.4
Total Phosphorus	mg/L	0.042	0.219	0.05 (RSWQO)	NA
Dissolved Organic Carbon	mg/L	25.6	63.1	NA	NA
True Colour	TCU	63	115	NA	NA
Total Alkalinity ($CaCO_3$)	mg/L	225.3	398.1	NA	NA
Chloride	mg/L	5.4	34.1	230	250
Sulphate	mg/L	11.4	106.5	500	500
Specific Conductance (field)	µS/cm	381	806	NA	NA
Conductivity (lab)	µS/cm	418	799	NA	NA
pH (field)	pH units	6.5, 9.2	6.0, 10.8	6.5	RSWQO
Biochemical Oxygen Demand	mg/L	1.4	2.4	Based on DO	
Chemical Oxygen Demand	mg/L	75.6	221.3	Based on DO	
Dissolved Oxygen (meter)	mg/L	Saturation	1.44^m	6.5*	5*
Total Suspended Solids	mg/L	6.5	82.2	NA	NA
Turbidity	NTU	9	77	NA	NA
Oil and Grease	mg/L	1.09	4.17		
Metals					
Aluminum (total)	mg/L	0.061	0.162	ASWQG variable	RSWQO
Arsenic (total)	mg/L	0.0004	0.0009	RSWQO	0.005
Boron (total)	mg/L	0.05	0.07	0.055	0.2
Barium (total)	mg/L	0.084	0.138	0.088 (RSWQO)	NG
Cadmium (total)	mg/L	ID	0.00003	ASWQG variable	0.0011
Chromium (total)	mg/L	0.0007	0.0034	0.008	0.0083
Copper (total)	mg/L	0.0005	0.0008	0.007	0.17
Iron (total)	mg/L	1.0218	2.6364	NG	RSWQO
Mercury (total)	µg/L	ID	90%<MDL	0.005	0.013

Table 5.3 Water Quality Targets and Limits for the Muskeg River Cont.

Water Quality Parameter	Units	WQT Mean Target (Yellow)	WQT Peak Target (Yellow)	WQL Mean Limit (Red)	WQL Peak Limit (Red)
Metals Cont.					
Lithium (total)	mg/L	0.0119	0.0154	NG	NG
Manganese (total)	mg/L	0.2359	1.2732	0.39	RSWQO
Molybdenum (total)	mg/L	0.0002	0.0003	0.028	0.73
Nickel (total)	mg/L	0.0006	0.0013	0.0072	0.062
Lead (total)	mg/L	0.0001	0.0001	0.001	0.002
Tin (total)	mg/L	ID	ID	0.0022	0.51
Selenium (total)	mg/L	ID	0.0007	RSWQO	0.001
Strontium (total)	mg/L	0.224	0.260	3.3 (RSWQO)	NG
Vanadium (total)	mg/L	0.004	0.013	0.017	0.16
Zinc (total)	mg/L	0.0004	0.0006	RSWQO	0.03
Organics					
Acenaphthylene	µg/L	80% <MDL	0.042	NA	5.8
Benzo(a)anthracene	µg/L	80% <MDL	0.0036	NA	0.018
Benzo(b,j,k)fluoranthene	µg/L	80% <MDL	0.0108	NA	NG
Benzo(g,h,i)perylene	µg/L	80% <MDL	0.0024	NA	0.0152
Chrysene	µg/L	80% <MDL	0.0048	NA	NG
Dibenz(a,h)anthracene	µg/L	80% <MDL	ID	NA	NG
Fluoranthene	µg/L	80% <MDL	0.0048	NA	0.04
Fluorene	µg/L	80% <MDL	0.0192	NA	3
Indeno(1,2,3-c,d)pyrene	µg/L	80% <MDL	0.0048	NA	NG
Napthalene	µg/L	80% <MDL	1.068	NA	1.1
Phenanthrene	µg/L	80% <MDL	0.0144	NA	0.4
Pyrene	µg/L	80% <MDL	0.0048	NA	0.025

* During open water periods only, m = minimum WQT for entire year recognizing that this occurs only in winter
ASWQG = Alberta Surface Water Quality Guidelines (Alberta Environment 1999).
RSWQO = Reach Specific Water Quality Objective development required (see Appendix A and Section 6.2.2)
80% <MDL = 80% of values are below the Method Detection Limit
NA = Not Applicable
ID = Insufficient Data
NG = No Guideline, candidate for RSWQO
See Appendix A for more details.

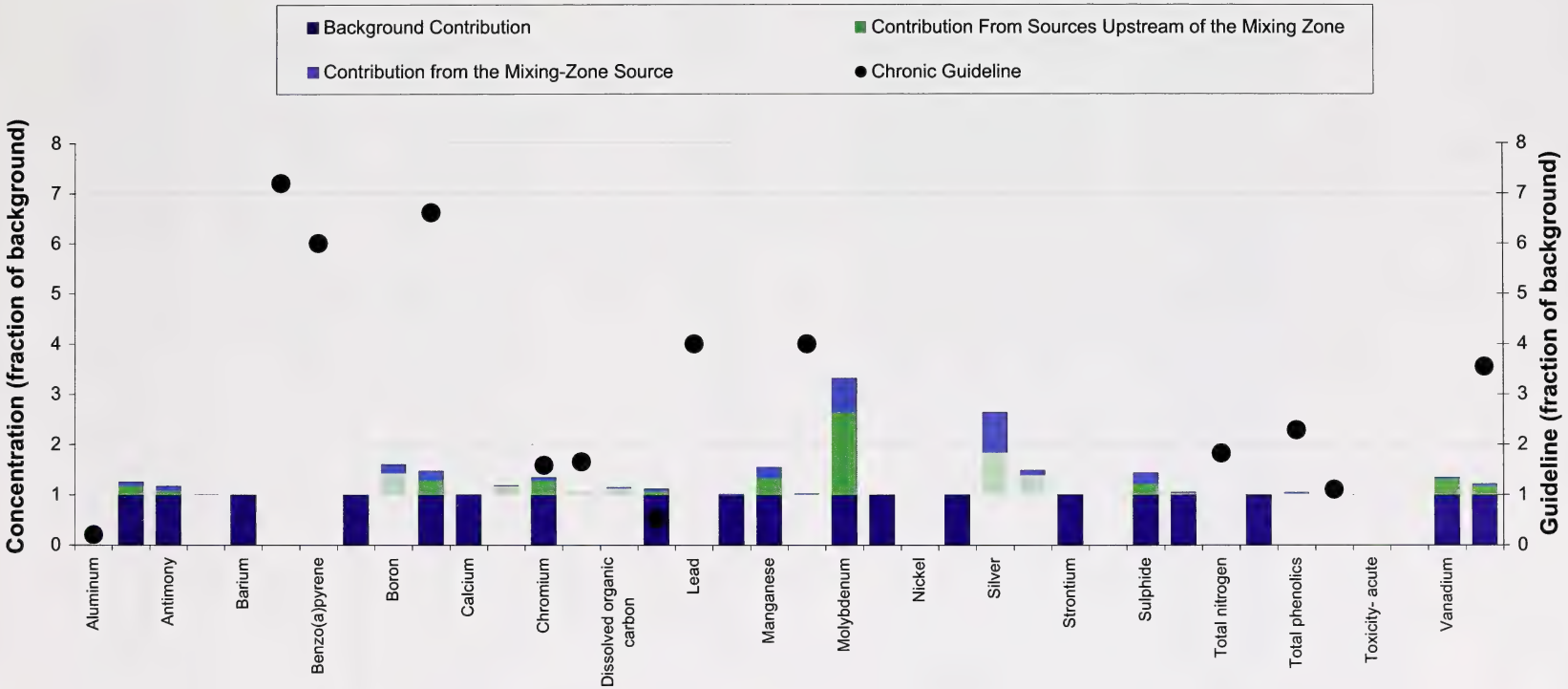

Figure 5.5 Predicted Concentrations and Sources of Water Quality Parameters in the Muskeg River – Far Future Scenario

Source: Golder 2004.

5.3 Monitoring and Implementation

The Interim Management Framework consists of two key components. The first was to establish water quantity and quality limits that are appropriate for the Muskeg River watershed. The second was to provide an assurance component that monitors for environmental effects. This second component is key for adaptive management. Monitoring can provide the necessary information for periodic updates of the water quantity and quality limits, where required.

Management actions dictated under the three conditions of the framework (green, yellow and red) must consider risk. Figure 5.6 presents the management steps to be taken during the implementation of the Interim Management Framework. As conditions approach and exceed Water Quantity Objectives and/or Water Quality Targets/Limits, monitoring must increase to determine if the expected impacts occur. This will allow the investigator to gauge the level of response that is required. The appropriate level of action required for each environmental condition is described below.

5.3.1 Green Conditions

Cumulative impacts from development on flows and water quality are minimal; the aquatic system is in near-background state. All developments and licence holders may operate under the conditions of their approval for water use and discharge criteria. No management actions or responses are required.

5.3.2 Yellow Conditions

Yellow conditions occur when the river is approaching changes away from background conditions and that exceed anti-degradation expectations. Impacts to the aquatic organisms of the river are considered to be negligible to low, however, more information on the source, trend and effect is required. Management activities are invoked where possible. Enhanced monitoring and risk management plans are required and shared management activities to improve conditions are promoted.

Yellow conditions can be either predicted by modeling or determined from monitoring information.

5.3.2.1 Yellow Condition Indicated by Modelling

Models, if implemented correctly, tend to present worst-case scenarios. Modelling should comply with the general framework presented in the Water Quality Based Effluent Limits Procedures Manual (AEP 1995). When model results indicate the

potential for yellow conditions, these should be verified with increased monitoring. This increased monitoring has been designated "Level 2" and is further explained below. The same process occurs if modeling indicates a shift to red conditions.

Level 1 Monitoring: is designed to evaluate current conditions at a monitoring site. The sampling regime and laboratory analysis for each parameter depends on the water quality characteristics at that site. For example, if a parameter varies over the seasons, sampling of that parameter will be conducted for each season. This allows the monitoring data to accurately describe the parameter of interest. This type of monitoring fulfills the needs of general performance reporting (e.g. Water Quality Index) and the management framework tools (models) for evaluating the potential to shift to yellow conditions.

Level 2 Monitoring: is triggered by an observed or modelled change or exceedance of Water Quality Targets and Limits. This type of monitoring provides a more detailed assessment and is designed to confirm the exceedance and investigate its sources. The heightened monitoring may focus on a single or limited number of parameters with additional spatial and temporal sampling. A Level 2 monitoring plan must be designed by the regional stakeholders within 60 days of a reported Target exceedance and submitted to the Regional Director.

5.3.2.2 Yellow Conditions Indicated by Level 2 Monitoring

When yellow conditions are indicated by monitoring, enhanced management activities must be implemented. The steps for enhanced management are:

- **Complete a risk assessment:** The risk assessment must be of sufficient detail as to be consistent with the risk of exposure from the substance. A risk assessment plan must be submitted to the Director of Alberta Environment (Northern Region) for approval. The risk assessment must be submitted in accordance with agreed-to timelines as proposed in the risk assessment terms of reference. Yellow conditions are based on anti-degradation and a case can be made in the risk assessment to allow site-specific exeedance of the Water Quality Target if the risk is considered acceptable and it can be demonstrated that conditions will remain stable or improve over time.

- **Plan mitigation options if needed:** A mitigation plan will be required if the risk assessment and subsequent review indicate mitigation is required to avoid long-term degradation of water quantity or quality in the Muskeg River. The plan must be submitted to the Director of Alberta Environment (Northern Region) for approval.

- **Implement mitigation plan:** The mitigation plan will be implemented with continued Level 2 monitoring until site specific goals are achieved.

5.3.3 Red Conditions

Red conditions (low flow based) for water quantity require mandatory adherence to cumulative loss limits.

Red conditions for water quality occur when concentrations increase to levels that do not allow protection of all uses. In general, these uses focus on the water quality guidelines for the protection of aquatic life. However, AENV considers the protection of all uses. WQLs were defined as the most stringent concentrations obtained from a search of Alberta, CCME and international guidelines. Many of these guidelines contain safety factors so that a WQL exceedance does not necessarily indicate an adverse effect has occurred. However, cumulative exposure to several stressors and the possibility for greater sensitivity of aquatic organisms in the site-specific condition make exceedances of either chronic or acute WQLs highly undesirable. The exceedance of WQLs for a certain parameter requires mandatory reductions in that parameter load.

5.3.3.1 Red Conditions Indicated by Modeling

Water quantity and quality models can be used to predict their potential to enter the red condition. The models often assign probability for these exceedances by using extreme events (e.g., drought or flood) with the probabilities themselves defined by an acceptable level of real data. When properly used, these models tend to over-estimate exceedances. Therefore, when red conditions are determined by modeling, the response should be to initiate a series of investigations. Immediate mitigation may not be required, unless monitoring data indicates a real exceedance.

When red conditions are predicted to occur, the modeling must provide information at a sufficiently detailed scale. This information should assess the frequency, duration and magnitude of exceedance, as well as the area in which the exceedance will occur. All of the conditions required for predicted yellow conditions apply for the red condition (e.g., risk assessment steps). However, the modeling effort for the red condition must go further than the risk assessment described for the yellow condition. Red conditions require an assessment of impacts as they relate to parameters that can be mitigated (e.g., X reduction in parameter loading = Y reduction in impact).

5.3.3.2 Red Conditions Indicated by Monitoring

When red conditions are detected by Level 1 monitoring, Level 2 monitoring must be employed as soon as river conditions allow to evaluate the cause and magnitude of the exceedance. When Level 2 monitoring indicates red conditions, mitigation options must be implemented immediately. Proponents can apply for a variance in the terms of their operating licence if there is sufficient evidence that the exceedance will not result in unacceptable impacts to the aquatic ecosystem. However, a significant amount of detailed information is required to justify changes to the specific limit for that parameter.

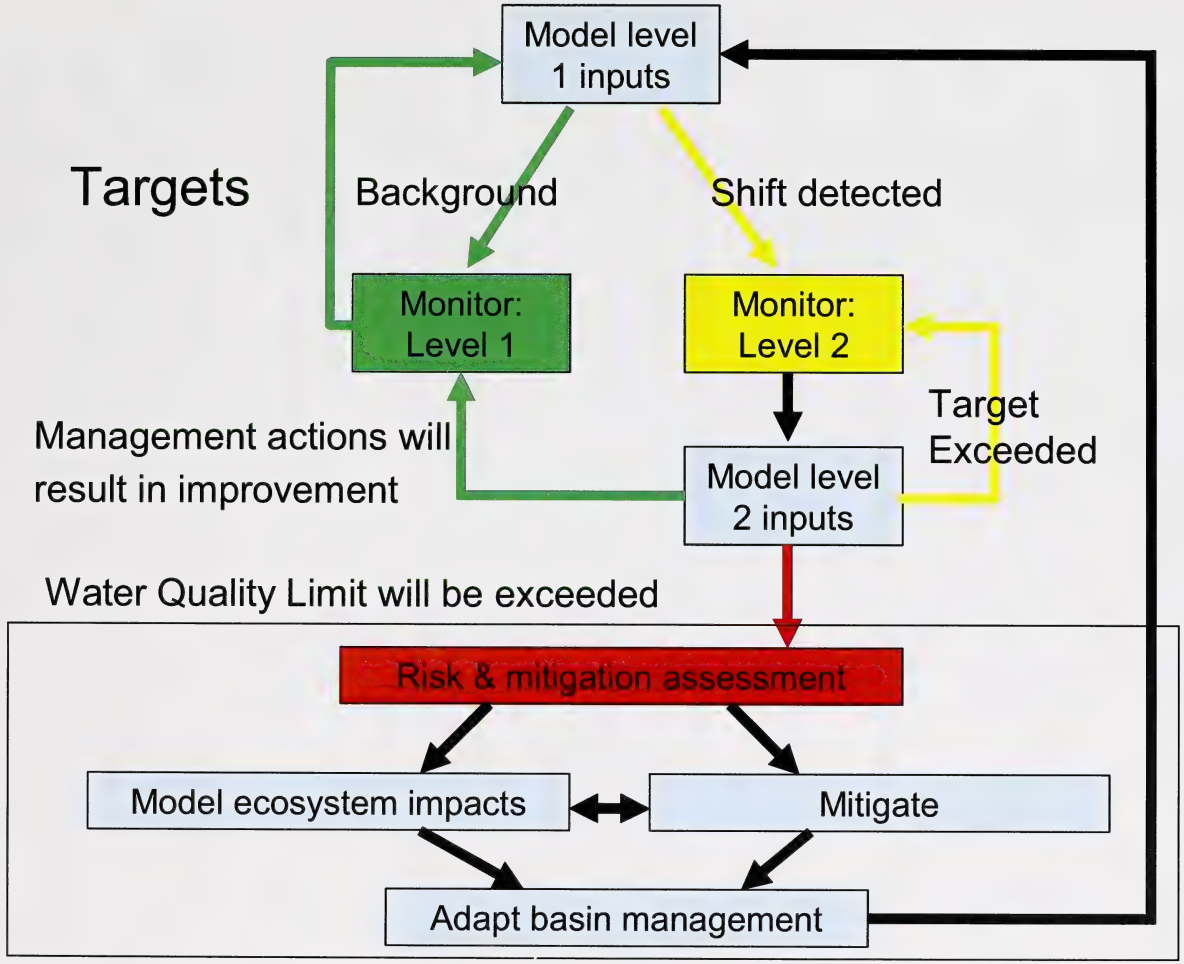

Figure 5.6 Implementation of the Muskeg River Interim Management Framework

6 NEXT STEPS

6.1 Muskeg River Comprehensive Water Management Plan

The Interim Management Framework for the Muskeg River watershed focuses on aquatic components and establishes minimum capacity limits to protect the water quantity and quality of the watershed. However, submissions received from First Nations and other stakeholders have indicated that the Interim Management Framework does little to address social, cultural and economic values of the Muskeg River watershed. The submissions also indicated the need for a comprehensive plan that balances economic development, social well-being and a sustainable environment. Recently, CEMA has decided to stop funding the comprehensive watershed management plan for the Muskeg River watershed. Both First Nations and other stakeholders have recommended that the Interim Management Framework should set the stage and establish a path forward to complete the comprehensive plan.

Alberta Environment recognizes that the Interim Management Framework is the first step to manage and protect the water quality and the water quantity of the Muskeg River watershed. Regarding the need for a comprehensive plan, AENV supports the development of a comprehensive management plan for the Muskeg River Watershed in a timely manner. AENV recommends the following directions to develop the comprehensive plan:

1. **Collaborative Effort:** AENV recommends a cooperative effort between regulatory departments, industry, First Nations and environmental groups to develop the recommendation for a comprehensive plan. AENV acknowledges that the comprehensive plan will address a wide range of interconnected social, economic and environmental issues and no single department or organization has the authority to develop and implement a management strategy. A holistic approach is required that focuses on management outcomes rather than a narrow jurisdiction and single issue.

2. **Consistent with Provincial Policies:** The comprehensive management plan should be developed to be consistent with existing provincial policies. These policies include Alberta's Commitment to Sustainable Resource and Environmental Management (GOA 1999), Alberta's *Water for Life* Strategy (GOA 2003), the Oil Sands Consultation: Multistakeholder Committee final report (June 30, 2007) and the Aboriginal consultation final report (June 30, 2007). These policies and strategies reflect the views and input of Albertans in establishing a vision and principles to guide future resource use and development in the province.

3. **Coordination and Consistency with Regional Management Initiatives:** The Muskeg River watershed is a part of a broader regional system, for which several planning initiatives exist. AENV recommends that the comprehensive management plan be coordinated and developed to be consistent with CEMA's Terrestrial Ecosystem Management framework and other plans relevant to the watershed.

4. **Legislative Context:** AENV recommends that the comprehensive management plan should be developed under the guidance and direction of the *Water Act* and the Framework for Shared Governance and Watershed Management Planning, currently underdevelopment by the Alberta Water Council (anticipated release date by June 2008). The final plan will be submitted to AENV for approval under the *Water Act*. The plan will also make recommendations, where appropriate, to other regulatory department such as ASRD, DFO and ERCB.

5. **End to Stalemate:** Over the past few years, the development of the Muskeg River Watershed Management Plan was centred on a debate between conservation and development and a definition of watershed integrity. As a result of this ongoing debate, little progress on the plan was achieved. AENV recommends focusing on trade-offs and explore possibilities for management alternatives that recognize both development and conservation needs to maintain societal benefits and ecological functions in the watershed.

6. **Timelines:** AENV is concerned about the lack of progress on the comprehensive plan. CEMA has failed to deliver the Water Management Plan as specified in the timelines outlined in several Joint Panel Hearings. AENV recommends that the Water Management Plan remain a high priority, and all stakeholders should commit to deliver this plan by no later than the end of 2009.

During the development of the Interim Management Framework, several issues were raised by First Nations and industry representatives. These issues are important, but are more appropriate for consideration under the comprehensive plan. The following are some key issues and management objectives that should be considered during the development of the long-term Water Management Plan for the Muskeg River:

1. **Management Policy for the Mainstem of the Muskeg River:** Very late in the process of developing this Interim Management framework, AENV received an application that includes a proposal to mine the oil sands within the upper reaches of the mainstem of the Muskeg River. AENV understands and respects that a number of parties have different views on managing the mainstem of the Muskeg River. AENV recommends that the comprehensive

management plan develop recommendations to manage the mainstem of the Muskeg River, in consideration of social, economic and environmental values.

2. **Water Conservation Objectives (WCOs):** The comprehensive management plan should consider establishing WCOs for Kearl Lake and the Muskeg River. As outlined in the *Water Act*, a WCO pertains to the amount and the quality of water established by the Director to be necessary for the protection of a natural water body or its aquatic environment.

3. **Watershed Approach:** The comprehensive management plan should be developed using a watershed-based approach by integrating environmental (terrestrial and aquatic components), economic, social and cultural issues to promote sustainable use of the watershed's natural resources.

4. **Water Quality Parameters:** The Interim Management Framework focused mainly on water quality parameters that have been previously detected in the river. However, it has been recommended that additional parameters, such as naphthenic acids and PAHs, be included in the comprehensive plan.

5. **Scenario Development:** Using an adaptive management approach, all stakeholders should be engaged during the development of sustainable management scenarios.

6. **Develop and Implement an Adaptive Management Plan:** A plan that includes monitoring, funding and governance to address compatible management solutions should be designed and developed.

6.2 Future Work

6.2.1 Water Balance Analysis for Kearl Lake

Kearl Lake is an important feature in the Muskeg River watershed. The Kearl Oil Sands project has developed a simulated water balance model from 1954 to 2002, using the Hydrologic Simulation Program Fortran (HSPF) model. In the future, the existing model may be used to assess the impacts of various development scenarios on the water balance of Kearl Lake.

The possibility of enhancing Kearl Lake to provide additional fish habitat or water storage to maintain Water Quantity Objectives in the Muskeg River could be an option in the future. Before the possibility of increasing its depth can be investigated, research is required regarding the effects these changes in depth would have on the lake.

Specifically, potential impacts on the wetland around Kearl Lake and effects on water chemistry such as the mobilization of mercury would require further research.

6.2.2 Reach Specific Water Quality Objectives

It is recommended that Reach Specific Water Quality Objectives (RSWQOs) be developed for several parameters. For these parameters, it was not possible to develop WQTs at this time for one of two reasons.

First, RSWQOs were recommended when no water quality guideline was available for a parameter, but where the development of a RSWQO would be beneficial to ecosystem management. For the Muskeg River, these parameters include several metals and organic compounds [total barium, total iron, total lithium, total manganese, total strontium, total vanadium, benzo(b,j,k)fluoranthene, chrysene, dibenz(a,h)anthracene and indeno(1,2,3-c,d)pyrene) (see Table 5.3)]. It is recognized that the nature of compounds with no water quality guideline is such that developing a RSWQO may not be within the capacity of a multi-stakeholder group for the Muskeg River. Larger provincial and national considerations for the parameter may exist, or guidelines may already be in development.

Second, the development of RSWQOs is recommended for parameters that currently exceed the yellow WQTs. The parameters within the Muskeg River that fall into this category include water temperature, total Kjeldahl nitrogen, nitrate+nitrite, total phosphorus, pH, total aluminum and total iron (see Table 5.3). These parameters naturally exceed the yellow WQTs for a variety of reasons, including the specific streamflow, soil and geological characteristics of the river and its drainage basin. More appropriate reach-specific objectives need to be developed that consider these natural conditions within the watershed. RSWQOs can also be developed proactively without a WQT trigger. A multi-stakeholder process led by industry in the Muskeg River watershed will be used to recommend RSWQOs to AENV.

7 CONCLUSIONS AND RECOMMENDATIONS

The Interim Management Framework meets the recommendations of the Joint Panel Hearings (EUB decision 2006-128) and is consistent with the directions of Alberta's new Cumulative Effects Management Framework (AENV 2007). This framework sets minimum thresholds to ensure adequate water quantity and quality as required for the protection of aquatic environment. The Interim Management Framework will be used to guide AENV regulatory decision-making process within the Muskeg River watershed until the end of 2009.

The Interim Management Framework is based on the precautionary approach. It focuses on water quantity and water quality, in keeping with AENV's regulatory and legislative mandate under the *Water Act and Environmental Protection and Enhancement Act*. Alberta Environment acknowledges that other features such as economic, social and culture issues are important for the watershed integrity. These components will be addressed in the comprehensive Management Plan.

Following is a summary of the water quantity and quality recommendations and management objectives. These objectives may be revised during the development of the Muskeg River comprehensive management plan, upon further consideration of mine operation plans, land use changes and social and cultural issues. The recommendations also include monitoring strategies to evaluate whether the water quantity and water quality limits are met. Finally, general recommendations to guide the management of the Muskeg River watershed are provided.

7.1 Summary of Water Quantity Objectives

The following water quantity goals are proposed for the Muskeg River:

- Ensure that there is no physical diversion or re-routing of the mainstem of the Muskeg River would occur by the end of 2009. However, AENV acknowledges that very late in the process of developing this interim framework, Shell Canada submitted an application for approval of the Jackpine Mine Expansion. This application includes a proposal to mine the upper reaches of the mainstem of the Muskeg River. The interim framework has not attempted directly to deal with this proposal at this time. AENV recommends that the decision on this application be guided by the public interest, considering economic, social and environmental values. Alternatively, a decision may be guided by further policy direction that may be provided by government in the future.

- Maintain an appropriate frequency of high flow events to maintain or improve aquatic habitat
- Maintain wet and dry conditions on river edge for riparian, fish spawning and invertebrate considerations
- Maintain sufficient water to ensure maintenance of water quality thresholds

Following are the Water Quantity Objectives for the Muskeg River:

- **Green:** Only 15% of the instantaneous flow is available for consumptive use in any week, should withdrawals occur. If watershed modifications result in increases in flow, the increases for the mean, median and peak flow statistics are expected to remain within 15% during the open water season. Winter increases in flow must not increase the variability of flow and must conform with the maintenance of water quality objectives.
- **Yellow:** Only 5% of flow is available for consumptive use, should withdrawals occur. Increased flows as a result of watershed activities cannot exceed the historic median flow for that week if flows naturally would have been in yellow conditions.
- **Red:** No water is available for consumptive use or other withdrawals. Increased flows as a result of watershed activities cannot exceed the historic median flow for that week if flows naturally would have been in red conditions.

Following are the Water Level Objectives for Kearl Lake:

- Target water level: 331.94 masl
- Minimum water level: 331.71 masl
- Maximum water level: 332.29 masl

7.2 Summary of Water Quality Targets and Limits

A yellow Water Quality Target (WQT) and a red Water Quality Limit (WQL) were defined for each selected water quality parameter for both chronic (mean) and acute (peak) conditions. Table 5.3 lists the parameters and their respective targets and limits.

Following are the management actions dictated under the three water quality conditions:

- **Green:** During green conditions, impacts on water quality are minimal and no management actions or responses are required.
- **Yellow:** During yellow conditions, impacts on water quality are likely, such that anti-degradation limits are exceeded. These conditions instigate an investigative action and are meant to guide management actions for evaluation and improvement where possible. Monitoring and risk management plans are required to improve water quality.
- **Red:** During red conditions, water quality impacts are high enough that not all uses are protected, and are considered to represent potential effects levels. Management actions are stringent and mandatory, including reductions in loading for the parameter or parameters that exceed the red conditions. Monitoring, risk management and mitigation plans are also required to improve water quality.

7.3 Monitoring Recommendations

An integrated monitoring plan for the Muskeg River watershed will be developed with the regional stakeholders. This monitoring plan will coordinate all off-lease monitoring activities that are currently done by individual companies. This coordination will provide an effective and efficient means to determine the current status of the water quantity and quality of the Muskeg River and its tributaries. It will also help determine the potential sources of impacts on water quantity and quality within the watershed.

The integrated monitoring plan will build on the current RAMP. The strategies and procedures put in place by the RAMP committee regarding water quantity and quality monitoring will continue regardless of the planned program. The integrated monitoring program may also streamline the company-specific monitoring requirements that are currently in EPEA approvals.

The integrated monitoring program may include the following:

- Sampling of key parameters
- Periodic checking and interpreting of results
- Reporting and communication of results by both industry and responsible government organizations
- Additional monitoring as required, such as in the event of accidental spills

The expected completion date for the integrated monitoring plan is spring, 2008.

7.4 Watershed Management Recommendations

Following is a summary of the recommendations made under this Interim Management Framework:

- Ensure no physical diversion or re-routing from the mainstem of the Muskeg River would occur by the end of 2009. The interim framework has not attempted to directly deal with the application for approval of the Jackpine Mine Expansion, which was received very late in the process of developing this framework and includes a proposal to mine the upper reaches of the mainstem of the Muskeg River.
- The Water Quantity Objectives and Water Quality Targets and Limits established in this document should be implemented immediately.
- Ultimately, management of the cumulative environmental effects in the Muskeg River watershed is the responsibility of the regulators. Therefore, AENV will take a direct leadership role and will make it a priority to ensure that the comprehensive Management Plan is completed in a timely manner.
- AENV acknowledges that First Nations' participation in the long term Muskeg River Water Management Plan is essential. Alberta Environment will ensure that First Nations' input and perspectives are included in the planning process.

The purpose of this Interim Management Framework is to guide management decisions being made by regulators in the immediate future regarding oil sands development within the Muskeg River watershed. The lower and upper limits on Water Quantity and the Water Quality Targets and Limits minimize the risks inherent within several regulatory approvals. These limits establish a system within which environmental impacts from development are minimized using key water quantity and quality parameters that are sensitive to oil sands development activities. Compliance with the

appropriate management actions will offset environmental impacts, reducing stresses on the ecosystem. Ongoing monitoring and follow up is required, including adjustments to the framework as necessary. Effective implementation of this Interim Management Framework will help to appropriately manage the Muskeg River watershed.

The Interim Management Framework will be in place until the end of 2009. AENV, in collaboration with First Nations and other stakeholders, will immediately initiate the development of a comprehensive management plan for the Muskeg River watershed.

8 STAKEHOLDER COMMENTS AND FEEDBACK

8.1 Aboriginal Consultation

As mentioned previously, consultation is essential for the success of the Interim Management Framework. Alberta Environment has a duty to consult with First Nations on initiatives that have the potential to impact lands traditionally used and protected by Treaty Agreements. Alberta Environment has engaged in consultation with the Chief and Council of the five First Nations of the Athabasca Tribal Council (ATC) or their designated directors from the Industry Relations Corporation (IRC), in order to fulfill Alberta's duty to consult.

Six consultation sessions with the First Nations were hosted by AENV between June 2007 to March 2008. In each session, First Nations' input and suggestions were collected. This information was subsequently validated in the next session to ensure that it accurately reflected what was presented. Input and suggestions were recorded using a SPAR Table format. SPAR stands for Suggest, Propose, Advise and Recommend.

Alberta Environment also met with the First Nations' technical representatives to review the Interim Management Framework Project Outline. The purpose of this meeting was to discuss in more detail the methodology that AENV was planning to use to set water quantity and quality limits. First Nations were also provided an opportunity to review the Draft Report. Subsequent meetings may be held to ensure that their inputs are reflected in the report.

In addition to a discussion of the Interim Management Framework, the consultation sessions were opportunities to continue to build working relationships between AENV and the IRC staff. The intent was to continue to improve communication and share information in a transparent manner.

Alberta Environment also consulted with other key stakeholders including the oil and gas industry, environmental groups and other regulatory agencies through CEMA's Watershed Integrity Task Group (WITG). Although AENV has received valuable input and suggestions from these other stakeholders, WITG had requested that, due to other commitments, the consultation process be conducted outside the CEMA process. However, AENV continued to consult these stakeholders on individual organizations and provided them the opportunity to review the Draft Report as well as subsequent meetings.

During the consultation process, a wide variety of topics were presented. Some issues were specifically related to the outcomes of the Interim Management Framework, while others were more general in nature. The following points highlight the key issues raised and AENV's response.

- Issue: In the event CEMA fails to deliver a Muskeg River Water Management Plan by 2009, AENV should take over and develop its own Water Management Plan as a contingency measure. How long would it take to develop this contingency plan?

  AENV Response: CEMA has recently decided not to fund the comprehensive management plan. However, AENV will take a direct leadership role in developing the comprehensive plan in collaboration with the First Nations and other stakeholders. Preferably, the comprehensive plan will be targeted to be completed by the end of 2009. If the comprehensive plan is not completed by the target date, AENV will consider revising and updating the interim framework. A timeframe of 10 to 12 months is anticipated to complete a revised backstop plan.

- Issue: While the Interim Management Framework is in place, there should be no major management decisions or new development approvals with respect to rerouting or diversions on the mainstem of Muskeg River until such a time that a new policy is in place.

  AENV Response: Very late in the process of developing the interim framework, Shell Canada has submitted an application for approval of the Jackpine Mine expansion. This application includes a proposal to mine the upper reaches of the mainstem of the Muskeg River. The interim framework has not attempted directly to deal with this proposal at this time. AENV recommends that the decision on this application be guided by the public interest considering economic, social and environmental values.

- Issue: The proposed Interim Management Framework will focus on water quality and water quantity only and will establish a minimum set of protection levels for the watershed. The comprehensive management plan is essential for comprehensively addressing watershed issues. Alberta Environment should ensure that the Muskeg River Water Management Plan is completed.

  AENV Response: The Interim Management Framework uses a precautionary approach to establish a set of management criteria for the Muskeg River watershed. However, the comprehensive management plan is expected to comprehensively address water resource issues identified through the Regional Sustainable Development Strategy.

These issues include the long-term hydrological and ecological integrity of the Muskeg River watershed. As recommended by the Kearl Oil Sands Joint Panel Hearing, AENV will ensure that the comprehensive management plan is completed and approved on a priority basis.

- Issue: The FN IRCs would like to participate and be involved earlier in the process for the development of the Muskeg River Water Management Plan. However, because the majority of IRC members have opted out of the CEMA process, there are concerns that their participation in this process may be limited. Alberta Environment and the IRCs should continue to keep their channels of communication open and transparent.

  AENV Response: Alberta Environment recognizes that a Water Management Plan is a shared responsibility. Alberta Environment also embraced a philosophy of partnership and collaboration to develop shared environmental outcomes. Alberta Environment will ensure First Nations participation. As part of the consultation process, AENV will continue to work with the IRCs and ensure that First Nations' input and perspectives are considered in the comprehensive management plan.

8.2 Stakeholder Draft Review

The draft Muskeg River Interim Management Framework was made available to the First Nations' IRCs, affected industry, government regulatory departments and other interested groups to provide their comments and feedback. A total of 12 written submissions were received during the review period. These submissions cover a broad spectrum of issues including outcomes, management objectives, technical evaluation and clarification, planning process, monitoring and editorial suggestions. The purpose of this section is to provide a brief synopsis of all comments and feedback that have been received, followed by AENV's response.

All submissions were considered for possible revisions to the draft Interim Management Framework. Individual comments were summarized and grouped into categories. A detailed summary of the comments and feedback are provided in Appendix B. Some comments were determined to be beyond the scope and limits of the Interim Management Framework and were not considered for the plan revision. However, these comments were documented and, in some cases, were highlighted as an issue for future consideration in the comprehensive Management Plan. Other comments that could be considered for revisions to the Interim Management Framework were addressed and where appropriate, changes to this document were made.

Within the context of this review, substantial support for the Interim Management Framework was found. Most of the submissions indicated that the Interim Management Framework is a good start to the management of water quality and quantity, in the absence of a comprehensive management plan. Others noted that the framework is long overdue in achieving regional goals to enable sustainable oil sands development, while maintaining a minimum level of environmental protection.

As expected, critical differences exist among stakeholder's interests and perspectives regarding the outcomes and focus of the Interim Management Framework. Some of the industry submissions indicated that the outcome of the Interim Management Framework will limit both approved and future oil sands developments. Industry members are concerned about the protective limits of the Interim Management Framework and the lack of consideration of the intensive development in the Muskeg River watershed, as recommended by other government policy documents and the focus of CEMA's Sustainable Ecosystem Working Group's current work. Industry members felt that the draft Interim Management Framework was biased toward conservation.

From another perspective, the IRCs and other submissions noted that the Interim Management Framework does not fulfill the recommendations of the Joint Panel Hearing for the Kearl Oil Sands Project. The original priority to develop a full backstop for the Muskeg River Water Management Plan was changed to narrowly focus on water quantity and quality, as per the mandate of AENV. These submissions also noted that protecting water quantity and water quality alone does little to address social and cultural concerns. Some submissions questioned when AENV would engage other regulatory departments and include land-based components in the Interim Management Framework.

It is clearly important to hear and respond to the issues and concerns of the various stakeholders in the region. However, it was a challenge to address the different interests and incorporate all comments into the revised Interim Management Framework. Alberta Environment values the comments and concerns of all the stakeholders and is committed to achieve a balance between oil sands development and the protection of environmental values in the Muskeg River watershed. The following presents a brief synopsis of the submissions and AENV's response.

8.2.1 Conflict with Development and Regulatory Concerns

Key comments and recommendations were:

- The Interim Management Framework in inconsistent with approved and proposed projects in the watershed, and would significantly limit their development.

- The Interim Management Framework is inconsistent with Provincial policies and initiatives (IRP, CEMA, SEWG) and other government departments (Alberta Energy, SRD) that expect intensive development in the watershed.

- There is an imbalance between development and environmental protection and a lack of recognition of watershed degradation that will occur due to increased development. The water quantity and quality targets and limits against a pristine benchmark are in conflict with SEWG and ERCB designation of the watershed as a development landscape.

- Maintaining environmental conditions to as close as natural as possible may not be realistic considering the proposed disturbances.

AENV response: AENV acknowledges the above issues and concerns. However, most of these concerns are beyond the scope and the limits of the Interim Management Framework. The management objectives of the Interim Management Framework are intended to be in place until the end 2009. Thus, the Interim Management Framework is a contingent plan (backstop). Alberta Environment believes that the proposed management objectives are appropriate and achievable during the interim framework, while most of the developments are in their early stages. However, AENV is aware of the proposed large scale development and the resulting intensive land use of the watershed. For this reason, AENV acknowledges that the management objectives for the Interim Management Framework would be revised during the long-term Water Management Plan, upon further consideration of mine operation plans, land use changes and social and cultural issues.

AENV is aware of the fact that in a development landscape, ecological degradation will occur and that protection of environmental flows necessarily entails trade-offs with other potential water uses. It is therefore important that the water needs of a river ecosystem be defined using current, best-available information and knowledge. Information and knowledge that can improve on these estimates is expected as part of the long term plan development. It is envisaged that the requisite knowledge will be collected prior to the development of the comprehensive Management Plan.

As an interim measure, water quantity and quality targets are pegged against pristine benchmarks that proactively protect the watershed against ecological damage. Alberta Environment cannot measure watershed impairment with values derived from an already impaired watershed. Alberta Environment used the pristine conditions to measure the level or degree of impairment as developmental activities proceed in the watershed.

Based on the above concerns , the following changes and clarification have been made in the draft Interim Management Framework:

- **Section 4, a subsection on the precautionary approach has been added. This section provides further discussion on the rationale and the criteria for setting management objectives.**
- **Section 7.1, the first objective, was revised to read "ensure no physical diversion or re-routing of the mainstem of the Muskeg River until the end of 2009.**
- **Section 7.4, the first recommendation was revised as per the above point.**
- **Section 7.4 was revised to reflect CEMA's decision to stop funding the comprehensive Water Management Plan. The revised section highlights the need for a joint effort between regulatory departments, industry, First Nations and environmental groups to develop the plan.**
- **Section 7.4, coordination with regional planning initiatives, was expanded to further clarify the consistencies with other Provincial policies and particularly with the work of SEWG.**

- Preventing diversions from the mainstem of the Muskeg River would affect Shell's expansion mine plans and regulatory approval of the Imperial Kearl Oil Sands project.

  AENV Response: This recommendation applies until the comprehensive Management Plan is completed, which is expected by the end of 2009. Alberta Environment is aware of Shell's recent proposal to mine 21 km of the Muskeg River and the existing approval of Imperial's Kearl Oil Sands. However, AENV acknowledges the importance of the Muskeg River and recommends that the comprehensive plan will develop management objectives for the upper and the lower reaches of the river in consideration of social\cultural and economic values.

- Slight revisions to the approach are suggested.

  AENV Response: The paragraph will read: " .... Water quantity and quality objectives and targets are good surrogates for monitoring ecosystem health. Assessing changes in water quantity and quality is therefore a powerful tool for identifying changes to other ecosystem components. Alberta Environment recognizes that this is not a complete approach. A comprehensive approach would also include aquatic organisms which are integrators of cumulative environmental effects. However, their response to the net result of changes could prove

difficult to interpret, especially when the changes have a synergistic effect on the organisms. A comprehensive monitoring and management plan will address the effects that change in environmental components will have on the aquatic communities. Meanwhile, AENV has provided the best available approach for defining thresholds that can be determined with existing data and managed with certainty in time and location. "

8.2.2 Joint Panel Recommendations (Full Backstop)

Key comments and recommendations were:

- Inconsistent with Joint Panel Hearing recommendation for full backstop.
- Focus is only on water quantity and quality.
- Land-based activities and terrestrial issues should be addressed as well as aquatic health and fish.

AENV response: The Interim Management Framework addresses the immediate needs of AENV in establishing a minimum capacity limits to protect the water quantity and water quantity of the watershed. Alberta Environment acknowledges that this is not complete approach for an integrated management plan and recognizes that it does little to address economic, social, cultural and traditional values of the watershed. However, the Interim Management Framework fulfills what the Government of Alberta communicated at both the Muskeg River Mine Expansion and the Kearl Oil Sands Project hearings. The Government of Alberta indicated that pending the development of an integrated water management framework for the Muskeg River basin, "AENV would consider other options for implementing comprehensive criteria that would influence development in the Muskeg River basin" (EUB Decision 2007-013). Alberta Environment also noted that a "minimum" backstop would be considered for determining thresholds for water quantity and quality in the Muskeg River basin. The Joint Panel supports AENV's implementation of interim measures for water quantity and water quality in the Muskeg River basin, until the comprehensive long-term Water Management Plan is completed and accepted.

8.2.3 Technical and Modeling Evaluation

Comments on the technical aspects of the Interim Management Framework were grouped into critiques of the methods, suggestions for improving the data and analyses within the methods applied and the application of knowledge derived from the methods applied. The first concern represents changes in the fundamental basis for evaluating the targets to be achieved in the Muskeg River. These important recommendations affecting the fundamental Interim Management Framework are to be addressed during the development of the long-term Water Management Plan for the Muskeg River. The latter two issues will be addressed both in the Interim Management Framework and the long-term Water Management Plan. The primary concerns regarding technical and modelling issues were:

- The lack of scientific knowledge and understanding of the linkage between yellow and red threshold conditions and their effect on the aquatic ecosystem.

- The desktop method for instream flow needs determination is inadequate to address the complexities of the watershed in the context of industrial development.

  AENV Response: Conflicting demands on water resources often present a dilemma for watershed planners. The question that begs to be addressed in such studies is – how much can the natural flow regime be altered and still ensure ecosystem health and integrity? In the case of the Muskeg River watershed, the question can be rephrased as, what is the seasonal minimum flow regime required to sustain ecosystem health in a river system that is being developed for heavy industrial mining? In other studies of this nature, the solution has involved identifying the quantity, timing, and variability of flows required to maintain desired levels of population biomass and biotic diversity - termed the instream flow needs of the system. Alberta Environment has adopted this approach to address water needs of the river ecosystem proactively using a science based process for developing environmental flow recommendations. The goal is to maintain ecosystem health while also preventing what could be termed as irreversible future ecological damage. The alternative method based on rewarding habitat enhancements as mitigation for cumulative effects is equally not a good measure of watershed integrity.

  Because of the inherent complexity of ecosystem responses to variable flow regimes, uncertainty exists in the establishment of thresholds. Given this uncertainty, AENV has attempted to err on the side of caution. However, AENV clearly understands that being wrong about environmental flow needs may result in one of two potentially large consequences. If the target/limit is not stringent enough, the instream flow regime will not meet ecosystem needs, in which case it will

degrade, with an associated loss of ecosystem function. If the target/limit is too stringent, potential industrial uses of the water will be unnecessarily limited, with social and economic consequences. The objective was to protect the aquatic ecosystem prior to it being seriously compromised.

In summary, the process of determining environmental flow needs should be viewed as an iterative process, in which water management actions under the yellow and red conditions are viewed as test cases that must be monitored and evaluated carefully, enabling scientific refinement of environmental flow recommendations over time.

Below are AENV's responses to some of the stakeholder's specific concerns:

- Water quantity objectives in the green condition are unclear. A percentage of mean monthly or mean summer flows should be used, rather than a percentage of instantaneous flow.

  AENV Response: Water quantity objectives based on a range of recommended flows in a 7 day period (mean weekly flows) are more sensitive to ecological responses than those based on mean monthly or mean seasonal flows. Therefore, these objectives are more stringent and more protective of water use, particularly in years with low discharges.

- Every existing and planned oil sands mine should be reviewed to determine the cumulative impact on water quantity and quality, in order to suggest appropriate mitigative measures and/or management actions.

  AENV Response: AENV agrees. There is language in the approvals that states that the approval may be modified as appropriate if the activities of the licenced operation are likely to negatively impact the environment.

- No detailed understanding is provided of how water quality parameters interact with each other and of the dynamic interactions between water quantity and quality. A tremendous data collection effort and basic science understanding is required to create a meaningful IFN.

  The desktop method for assessing changes in flow does not adequately address the complexities of the watershed. The Interim Management Framework will not be met under the development of approved projects. A more long-term, holistic view of the watershed should be taken. There is a question as to whether it is appropriate to hold a watershed that is slated by SEWG for intensive development to the highest management standard. A

solution may be to indicate that the Interim Management Framework is set to this standard because development is currently minimal, and this will ensure industry adheres to best practices.

AENV Response: The IFN assessment method used in this document uses an empirical approach to make a connection between river flow regimes and possible effects on the viability of aquatic communities. In this approach we use the hydrological regime to set limits under the hypothesis that maintaining a natural flow regime within the targets and limits as expressed in this document provides exceptional protection of three of the four pillars of the river ecosystem [biology, geomorphology, and connectivity (e.g. riparian habitat)]. When water quality is additionally impacted by effluents, these loads must be considered in context of the minimal changes in flow allowed under the desktop approach used here. A large and growing field of study with numerous peer-reviewed publications supports this approach. Water quality loads in the end must be evaluated against the impacts to aquatic life that occur due to sustained exposure and acute effects. The Interim Management Framework has identified these water quality limits again based on Provincially and nationally accepted criteria that themselves are determined from comprehensive toxicological studies. Specific loading limits that account for the interactions of flow with load as well as the complexities of reaction kinetics can be determined in later stages from the limits set in this interim Framework.

The method used for evaluating water quantity derives from the same general relationships that have become rules-of-thumb for IFN practitioners and that form the basis for the "desktop" method in Alberta. These general principles are applied here for two reasons:

- **The abstraction restrictions are recognized as being protective which we consider appropriate in the Interim Management Framework. CEMA has failed to address channel structure and geomorphology issues first identified in the Muskeg River Watershed Integrity Workshop (2002) and protective targets must be in place until these have been addressed in the long-term Water Management Plan.**
- **No information is available as to the potential for connectivity issues in the Muskeg River, therefore protective targets strongly supported by the literature on fluvial dynamics are appropriate.**

- It is unclear how the Interim Management Framework can provide certainty of watershed management when there is a lack of scientific understanding for the watershed. While acknowledging that the key stressors are land-based,

the Interim Management Framework does not address the very issues that affect water quality and quantity. More details regarding terrestrial issues would provide some assurance on how the watershed will be managed as a whole. This Interim Management Framework should address limiting the cumulative impacts of land disturbance to ensure water quality and quantity targets are met.

AENV Response: AENV recognizes that to achieve water quantity and quality objectives, the watershed must be maintained. This concept is as old as one of the hallmark papers for limnology (Naumann 1925). This knowledge supports developing a management plan for water quality and quantity as a first step because it is the integrator of watershed activities. Developing a water quantity and quality plan sets the stage for the iterative, complex and time intensive task of determining how to manage terrestrial disturbances through time and space as expected in the long term Water Management Plan. Watershed management is an iterative process, in which each water management action, such as rerouting tributary streams, is viewed as a test case that must be monitored and evaluated carefully, enabling scientific refinement of environmental flow recommendations over time. It is expected that AENV will institute a monitoring system response and will continue to conduct further research.

- Provide further justification for the use of the desktop approach to IFN considering that limited winter discharge records (e.g. 10 years) exist for the Muskeg River.

  AENV Response: The IFN analysis is based on best available data. McEachern and Noton (2002) implemented a simple hydrologic model to predict winter flows through to 2000, extending the winter record by 13 years.

- The yellow and red conditions should be tied to environmental consequences, not just absolute changes, as some changes (such as flows) may be positive. Slight changes to the definitions of the conditions are suggested.

  AENV Response: There is a need in the Muskeg River watershed for data that would tie yellow and red threshold conditions to ecological processes, particularly with regard to flow dependent biota. Again, implementation of flow recommendations is on an interim basis pending a comprehensive study on the consequences of threshold flows on aquatic and riparian habitat.

- Additional years' flow data from RAMP should be included.

AENV Response: We have not included the most recent data deliberately because activities in the basin are now at a scale as to potentially invalidate a representation of background conditions.

- There is insufficient data to establish a baseline for assessing the Interim Management Framework.

  AENV Response: The water quality database is robust for the AENV monitoring site at the WSC gauge and adequately represents low impact conditions that we consider sufficient to describe a baseline. The Interim Management Framework has the primary goal of ensuring the most important ecological functions and water quality are maintained such that impacts to the Muskeg River are as close to natural as possible until further information becomes available.

- Use of a 20% increase to define a shift towards degradation is arbitrary.

  AENV Response: The use of a 20% shift was a generalized approach combining recommended procedures for site specific guidelines and anti degradation (e.g. U.S. EPA 1994, CCME 2003). The general approach was considered appropriate after examining the variability of representative parameters. Ostensibly, the CCME-recommended method for the background concentration procedure using a 90 or 95% confidence interval was adapted such that a reasonable fraction change was consistent with anti-degradation.

- Use mean monthly or mean summer flow instead of instantaneous flow.

  AENV Response: Use of mean monthly and summer flows is not considered adequate at this time. Development has the capacity to greatly alter instantaneous flow conditions (e.g., peak flows), the impacts of which are not adequately represented by mean conditions over longer time periods. In the interest of protecting against increases in extreme conditions, weekly means are considered a maximum duration for management of flows in the Interim Management Framework.

- Use depth:area relationship and recurrence to manage Kearl Lake.

  AENV Response: For Kearl Lake, frequency was considered, hence flood and drought event water levels were used. Hypsographic type curves are not useful for managing such shallow lakes.

- Additional water quality sites and years of data should be included, particularly for naphthenic acids and DO.

AENV Response: Data from additional sites were considered in the assessment. However, the focus of the Interim Management Framework is on impacts to the Muskeg River as it may influence the most important habitat at the lower reach and the Athabasca River. In addition, the lower reach of the river was the only location where data were considered adequate to support a Interim Management Framework at this time. Expansion to other sites is recommended as the monitoring plan provides better information on upper reaches.

- Total naphthenic acids, PAHs, dibenzothiophene, sodium, salinity should be included in the targets and limits.

  AENV Response: Within the existing water quality data, AENV chose representative organic parameters that have been detected in the river, can be indicative of process-affected waters and have existing guidelines to determine red conditions. Total naphthenic acids and PAHs are monitored in release waters from individual leases and their evaluation will be included in the monitoring plan, however, sufficient information to support a target or limit was not adequate for the Interim Management Framework. We fully expect this information to be available for the long-term Water Management Plan. Sodium was tightly correlated to chloride concentrations and generally is in potential release waters, hence it was considered redundant in the Interim Management Framework. We may re-evaluate and include sodium. The role of salinity on toxicity is not clear, as it has countervailing effects on chronic and acute toxicity of process waters. Inclusion of major cations or anions such as sodium or chloride serve a similar purpose.

- Suitable laboratory analytical methods should be prescribed for <MDL compounds.

  AENV Response: Suitable laboratory and analytical detection limits will be established as part of the monitoring plan.

- Mitigation for habitat loss should be considered.

  AENV Response: Habitat loss mitigation and other long-term considerations are better addressed in the long-term Water Management Plan.

- Monitoring of other sites and inclusion of these sites in future management should be carefully evaluated.

  AENV Response: A comprehensive monitoring plan for the Muskeg River is currently being designed for implementation in spring, 2008.

- The licensing of closed-circuit removal of water from the system is unclear particularly during yellow or red conditions.

  AENV Response: AENV has proposed low- allowable abstractions for the Muskeg River in the short –term precisely to solicit response from lease holders as to their water management activities and to encourage reporting of water budgets on site.

- Current understanding of water quality and quantity relationships is not presented.

  AENV Response: A technical document will follow that updates the current understanding provided by McEachern and Noton (2002) for the Muskeg River.

8.2.4 Monitoring and Implementation

Key comments and recommendations were:

- There was a lack of detail in the Interim Management Framework.

  AENV Response: The monitoring plan is currently being developed by AENV and will be available for comment and improvement in early February, 2008. This plan will be implemented in spring, 2008 by AENV staff with support from operators in the Muskeg River basin. Once the monitoring plan is completed, it will become a feature of the Interim Management Framework as a supplemental addition.

  Sampling frequencies will occur on a monthly basis at sites throughout the basin, including several major tributaries and Kearl Lake (the lake and tributaries will be sampled less frequently during ice cover). Daily sampling of storm events will occur for the first year using automated samplers. Continuous monitoring for some important parameters will occur using a combination of hydrolab units and Hobos. Data will become part of the Government of Alberta water data warehouse, a publicly accessible database on which annual performance reporting will occur.

8.2.5 Muskeg River and Kearl Lake

Key comments and recommendations were:

- Fort McKay expects to be consulted regarding any proposal to re-route the mainstem of Muskeg River or deepen Kearl Lake and recommends:
  - It's preferable to maintain historic water levels by preventing water loses and protecting water quality than to further disrupt the lake by artificial deepening.

    AENV Response: The Interim Management Framework recommends that the historic water levels of Kearl Lake should be maintained over the next two years. The potential to deepen the lake is a future suggestion that will be examined in the long-term plan.
  - No major decision or new approvals with respect to re-routing the mainstem of the Muskeg River should occur until a long-term management plan is in place.

    AENV Response: AENV acknowledges the ecological, cultural and traditional values of the mainstem of the Muskeg River and Kearl Lake. The Interim Management Framework recommends no re-routing of the mainstem of Muskeg River until the end of 2009. Any future proposal to re-route the Muskeg River will be thoroughly examined under the *Water Act* and *EPEA*. Concerns raised by the First Nations and other stakeholders will be carefully considered in the decision-making process. As noted previously, the Interim Management Framework recommends that management objectives for the upper and lower reaches of the Muskeg River should be developed by the comprehensive Management Plan.

8.2.6 Legal, Policy and Compliance

Key comments and recommendations:

- The legal basis of the framework under the *Water Act*, *EPEA* and other government policies such as the *Water for Life Strategy* and Watershed Management Framework is unclear.
- It is unclear how the Interim Management Framework will be applied to day to day management of the existing and approved projects.
- AENV should address the weak legal basis of the Interim Management Framework and establish a compliance system to enforce its management objectives.

AENV Response: The above comments are acknowledged and a new section was included in the report to address the legal and regulatory framework.

8.2.7 General Comments and Editorial Suggestions

Key comments and recommendations:

- Short review period during the Christmas holidays was insufficient.

  AENV Response: Three working weeks were considered a reasonable time for review.

- Slight changes of the definition of ecological integrity is recommended.

  AENV Response: The phrase 'a measure of ' replaced the word 'ability'. The sentence reads as: It is a measure of the ability to support and maintain a balanced, adaptive system with a species composition, diversity and functional organization that is comparable to that of natural systems.

- Clarification of ecological health and ecological integrity definitions is required as they overlap.

  AENV response: This comment would be appropriate to address in the comprehensive Management Plan. The definitions included in the glossary are from the literature and are intended to provide context. Alberta Environment acknowledges that ecological integrity and ecosystem health mean different things to different people.

- Suggests renaming “target” with “limits” or threshold”.

  AENV Response: The term “target” is used to describe the green/yellow boundary and is appropriate as we want to achieve green status. The term “limit” is already used to describe red conditions. The term “threshold” was considered too ambiguous to use because both targets and limits are thresholds.

- Definition of water quality target, water quality limits and the yellow and red conditions require improvement and clarity.

  AENV Response: The definitions provided are considered clear.

- Slight revisions to the discussion on peak flows are suggested.

AENV Response: Rainfall has been included among the seasonal events that affect stream flow. The paragraph in part reads as follows: Several seasonal events affect streamflow in the Muskeg River, including spring snowmelt, rainfall, summer thaw of the peatlands and winter ice cover. Peak streamflow usually occurs as a result of the freshet in combination with spring rainfall or toward the end of a wet summer.

- It's unclear whether the new Syncrude mine has been publicly disclosed.
- AENV should defer evaluation of Shell's expansion plans and the Petro Canada Fort Hills project until the cumulative impacts of these projects can be understood within the context of the framework.

AENV Response: The Interim Management Framework is meant to provide a context for how these and other projects consider and present the impacts of their expansion plans. Along with standard environmental assessment tools, we will use the framework to assist in our evaluation, and not as a reason to defer evaluation.

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Appendix A

Methods to Establish Water Quality Targets / Water Quality Limits

Water Quality Targets (WQTs) – Yellow Management Zone

Water Quality Targets (WQTs) were established from background concentrations, assuming that the current historic record adequately represented background conditions. Targets were established as 20% increases in mean and peak (99.91 percentile) statistics. The exceptions were dissolved oxygen (DO) and pH.

For DO, a decline is the significant management end-point, however, in the Muskeg River concentrations can range from saturation to near zero. The lower range of DO occurs during the winter and is well below known effects levels. The WQT for DO reflects this range. However, the Water Quality Limit (WQL) is only applied to open water periods, when it is important for fish spawning.

For pH, both a decline and an increase can be detrimental. This is largely because pH, as a representation of hydrogen ion activity, is a master variable for the speciation of other toxic compounds. pH therefore was assigned low and high WQTs. The peak for pH was the 99.91 percentile plus 20%, the minimum recorded pH was 6.7, rather than subtracting 20%, an effects value of 6.5 for a 7-day mean and 6.0 for transient minima was selected based on a literature survey for brown-water systems was used (WRS 2003).

For the remaining water quality parameters, specific data were assessed by the methods consistent with McEachern and Noton (2002) and summarized below:

- **General Chemical Parameters:** All data available for the Water Survey of Canada site on the Muskeg River were considered when establishing background concentrations. For most parameters, these data extend from 1972 through 2002. When missing data created the potential for bias (due primarily to seasonality) entire years were excluded or, missing data was estimated when strong empirical relationships existed and the missing data to be estimated were few.

- **Metals:** Due to a change in laboratories, procedures and detection limits, only data from 1996 to 2002 at the Water Survey of Canada site were used in calculating background concentrations. Metal concentrations were screened using two criteria; existing guidelines (aluminum, chromium, iron and manganese exceeded the guidelines), and relative concentrations from two potential source waters. When concentrations in these two potential source waters (process water represented by concentrations reported from the Tar Island Dyke and Syncrude Consolidated Tailings water) were more than 2 fold greater than ambient concentrations, the metal was included. These representative source waters contained concentrations for six metals that were several fold higher than ambient concentrations, but still well below existing guidelines. These six metals were included anyway. The result was

that all metals that were regularly represented in the historic record were included and none were excluded.

- **Organic Compounds:** All available data from both the Water Survey of Canada and Muskeg River mouth sites were included as a single representation of lower reach concentrations. A majority of concentrations were recorded as below method detection limits (<MDL). While AENV generally treats <MDL results as half-detection limit concentrations for calculating general statistics, this procedure was considered inappropriate for establishing management targets. Instead, the ratio of undetectable to detectable values was assessed for each parameter, with the intent of maintaining this general frequency. Most parameters were represented by one to two detections in a record of 11 samples since 1998. A criteria of maintaining more than 80% of samples below detection (80% <MDL) was therefore chosen for all organic compounds to represent long-term mean conditions. Peak WQTs are based on the peak observed concentration plus 20%, rather than the 99.91 percentile.

Water Quality Limits (WQLs) - Red Management Zone

Effects-based criteria form the basis for defining the red management zone, or Water Quality Limits (WQLs). In general, existing Albertan, Canadian and international water quality guidelines for the protection of aquatic life were used to establish the WQLs. Exceptions to this occurred under the following circumstances:

- Absence of a guideline where adverse effect could occur
- Guideline is lower than background concentration
- Adequacy (site specific factors) of existing guideline
- Guideline is more than 10 times the background concentration

Absence of Guidelines

There were a number of parameters for which aquatic effects guidelines were not available. As an alternative, guidelines that protect other water uses such as irrigation, drinking water and aesthetics were used to determine the WQLs.

Two categories were applied to parameters where use guidelines were unavailable:

- RSWQO (Reach specific water quality objective) indicates that a RWSQO must be developed for this parameter as a consequence of exceeding the

yellow WQTs. A multi-stakeholder process led by industry in the Muskeg River watershed will be used to recommend RSWQOs to AENV. RSWQOs can be developed proactively without a WQT trigger.

- NG (no guideline) indicates that no guideline is available and much like the RSWQO category, development of a RSWQO would be beneficial to ecosystem management. However, it is recognized that the nature of compounds with the NG classification is such that developing a RSWQO may not be within the capacity of a multi-stakeholder group for the Muskeg River as larger provincial and national considerations for the parameter may exist or guidelines may already be in development.

Guidelines Lower than Background Concentrations

Generic guidelines for the protection of aquatic life or other uses are effective management tools. However, these fail when they are exceeded by natural conditions at the local scale. Guidelines for the protection of aquatic life should not be exceeded under any circumstance except by rare extreme events (i.e., a one in three year maximum concentration or the 99.91 percentile [AEP 1995]). Aquatic organisms are exposed continuously and can be acutely affected by short duration exposures. However, these guidelines are often exceeded in natural surface waters for some parameters. When this occurs, it is typically because the parameters are present in the natural local environment and occur in forms that reduce their potential toxicity (e.g., AEP 1995, AENV 1999, U.S. EPA 2002, CCME 1999). For example, total aluminum, nitrogen and phosphorus concentrations often exceed guidelines in Alberta's larger rivers due to geologic and soil conditions. In such circumstances, the development of RSWQO is required. However, because generic guidelines do exist, these parameters have been assigned the generic guideline with the RSWQO designation indicating that the generic guideline will be applied until such time as a RSWQO can be developed.

Appendix B

Consultation Comments and Questions from Stakeholders

General Issues	Source of Advice	Specific Comments
Approach	Syncrude Canada Ltd.	• The IMF is inconsistent with AENV's past participation in the EUB and Joint Panel hearings processes for these development projects.
	Shell Canada	• Slight revisions to the approach are suggested. • The yellow and red conditions should be tied to environmental consequences, not just absolute changes, as some changes (such as flows) may be positive.
	Imperial Oil Resources	• The IMF only considers baseline water quantity and quality issues.
	Pembina Institute	• The IMF uses a reactionary, not precautionary approach. Management actions are taken only after changes have occurred and within the yellow condition, in which a return to the green condition may not be possible. It is unclear how Level 1 and 2 monitoring would ensure that ecological integrity is not compromised. Few preventative measures and management actions are required in advance of degradation.
	ACFN and Fort McKay IRCs	• Clarification is required for the conditions considered acceptable under the red conditions (re: statement "Proponents can apply for a variance in the terms of their operating licence if there is sufficient evidence that the exceedance will not result in unacceptable impacts to the aquatic system".
	Fort McKay IRC	• By focusing only on water quantity and water quality, the IMF does not fulfil the Joint Panel for the Kearl Oil Sands Project's recommendation to provide a full backstop. Land-based components need to be included. The spatial extent (monitoring and management) of the IMF needs to be expanded to the entire watershed, and not focus only on the mouth of the Muskeg River. Water quantity and water quality goals need to be developed for all the reaches of the Muskeg River and key tributaries. Aquatic ecosystem health and fish also need to be addressed.
	Mikisew Cree FN	• It is unclear how the IMF can provide certainty of watershed management when there is a lack of scientific understanding for the watershed. While acknowledging that the key stressors are land-based, the IMF does not address the very issues that affect water quality and quantity. More details regarding terrestrial issues would provide some assurance on how the watershed will be managed as a whole. This IMF should address limiting the cumulative impacts of land disturbance to ensure water quality and quantity targets are met. • More support is needed to show how using water quality targets can maintain water quality with no significant deterioration. • By focusing on water quality and quantity only, the IMF is not an appropriate surrogate for the long-term WMP, nor does it meet the Joint Panel recommendations. • Comprehensive management actions for supporting the goals of the IMF appear to be lacking.

General Issues	Source of Advice	Specific Comments
Approach Cont.	Mikisew Cree FN Cont.	• It is unclear how the relative contribution of impacts and their relationship with the thresholds will be evaluated. • The Joint Panel requires that guidelines and management systems should proactively guide development, however, the IMF calls for reactionary responses in several instances. Management actions and monitoring are only implemented after conditions are impaired. The IMF uses a reactionary approach, when a precautionary approach is needed to prevent degradation in the first place. • AENV needs to identify thresholds for key land-based activities that can impact water quality and quantity, using additional data collection and TEK.
	ERCB	• Given that CEMA is no longer funding a framework development for the Muskeg River, statements concerning the need for CEMA to complete the WMP are irrelevant. Clarification of AENV's plans to address completion of the integrated Muskeg River Management Framework as requested by ERCB and Joint Panel Hearings is required.
Regulatory Concerns	Syncrude Canada Ltd.	• The IMF is inconsistent with Provincial policies and initiatives (IRP, CEMA, SEWG) and other government departments (Energy, SRD) that expect intensive development in the watershed. • It is unclear whether the existing compensation agreements between developers and DFO regarding aquatic ecosystems can be constructed within the IMF.
	Petro-Canada Oil Sands Inc. (PCOSI)	• The water quantity and quality targets and limits against a pristine benchmark is in conflict with SEWG and ERCB designation of the watershed as a development landscape.
	Imperial Oil Resources	• It is unclear how the IMF is in alignment with other government policies, including Alberta Energy's resource development and the ERCB policies on energy conservation. The IMF requires a concerted effort between government agencies, including Energy, AENV, DFO and ERCB. • The IMF does not account for or describe how approved DFO compensation schemes will operate in the watershed.
	Pembina Institute	• The legal basis of the IMF is unclear in terms of the *Water Act* or *Water for Life* Strategy. It is unclear how the IMF will be applied to existing and approved projects. The responsibilities of government agencies and stakeholders are not defined. It is recommended that the IMF be adopted as a formal policy on an interim basis in order to enforce compliance with its management actions.
	Fort McKay IRC	• It is unclear if or when AENV will engage other government departments to include land based components to develop a full backstop.

General Issues	Source of Advice	Specific Comments
Regulatory Concerns Cont.	Mikisew Cree FN	• The legal basis for the IMF is unclear. It is unclear how regulatory approvals will be affected and how other government departments will be involved. Insufficient detail is provided regarding how the IMF will inform and influence regulatory decisions and how implementation will be enforced. The IMF should be adopted as formal policy on an interim basis. • AENV needs to adopt a Water Management Plan under the *Water Act*, in order to establish Water Conservation Objectives that will be legislated. • The responsibilities of government, FN and other stakeholders are not defined. In order to reach the objectives of the IMF, it appears to rely solely on cooperation among FN and stakeholders. However, impetus from regulators should be required. • The definitions for Water Quantity Objective, Water Quality Objective and Water Quality Target do not appear to have any basis in law or policy to establish or enforce these limits.
Conflict with Development	Syncrude Canada Ltd.	• The IMF is inconsistent with approved and proposed projects in the watershed, and would significantly limit their development. It is unclear whether the impacts predicted in recent EIAs are within the limits established under the IMF.
	Petro-Canada Oil Sands Inc. (PCOSI)	• There is an imbalance between development and environmental protection and a lack of recognition that watershed degradation will occur due to increased activity.
	Shell Canada	• The management goals outlined in the IMF are not achievable by existing approved projects in the longer-term (closure) and are inconsistent with the SEWG-designated intensive use for the watershed. It is unclear what level of watershed integrity is appropriate for a watershed zoned for intensive development. It is unclear whether the management objectives of the IMF would differ from the long-term WMP. Suggests that the IMF objectives may be appropriate for the 2 years, but different objectives would be appropriate for the long-term WMP. • If diversions from the mainstem were prohibited from within the whole watershed, these limitations in the upper reaches would affect Shell's expansion mine plans and Imperial's approved plans. This would potentially sterilize hundreds of millions of barrels of bitumen. • Shell's expansion plans would not meet the green conditions for peak flow, mean flow or flood criteria. It is unclear what time scale variability is measured on.
	Imperial Oil Resources	• There is a direct conflict between the IMF objective of not compromising the watersheds' ecological integrity with the oil sands development. Maintaining environmental conditions to as close to natural as possible will significantly limit development of both approved and future projects. The IMF may not be realistic, considering the number of approved projects, in addition to project applications. There is little evidence that the IMF balances environmental needs with economic development.
	ACFN and Fort McKay IRCs	• It is unclear whether the prohibition of rerouting the mainstem of the Muskeg River or deepening Kearl Lake would be enforced for mining projects.

General Issues	Source of Advice	Specific Comments
Conflict with Development Cont.	Mikisew Cree FN	• The goal of the FN to maintain environmental conditions to as close to natural as possible seems unrealistic considering the proposed disturbance.
	ERCB	• It is unclear whether oil sands developments with existing regulatory approvals are able to operate under the management objectives, particularly those for flow regime. An analysis of the impacts upon future oil sands development scenarios should be conducted. • The recommendation that there be no diversions or withdrawals from the mainstem channel of the Muskeg River during the term of the IMF is inconsistent with regulatory approval of Imperial's Kearl Oil Sands Mine that requires diversion of the Muskeg River.
Technical and Modelling Concerns	Petro-Canada Oil Sands Inc. (PCOSI)	• The 'Desktop' method for measuring watershed integrity is relatively imprecise. An alternative method rewards habitat enhancement as mitigation for cumulative and/or harmful impacts at other locations.
	Shell Canada	• Additional years' flow data from RAMP should be included. • The water quality summary should include sites other than just the mouth, particularly for naphthenic acids and DO. • The desktop method for assessing changes in flow does not adequately address the complexities of the watershed. The IMF will not be met under the development of approved projects. A more long-term, holistic view of the watershed should be taken. A slight revision to a sentence including the 85% minimum instantaneous flow recommendation is suggested. There is a question as to whether it is appropriate to hold a watershed that is slated by SEWG for intensive development to the highest management standard. A solution may be to indicate that the IMF is set to this standard because development is currently minimal, and this will ensure industry adheres to best practices. Several recommendations for the long-term WMP are made. A more detailed discussion on the limiting periods for flow is recommended. • The values for the key hydrologic parameters of Kearl Lake are questioned (suggests that RAMP data should be used rather than Golder data).
	Pembina Institute	• Water Quality Targets and Limits should be established for naphthenic acids.

General Issues	Source of Advice	Specific Comments
Technical and Modelling Concerns Cont.	ACFN and Fort McKay IRCs	• A baseline value should be used to establish and track the variations in flows and the use of the prescribed management objectives (i.e. the Q80 and Q95). • The objectives for both high and low flow conditions should be clearly described. • The sedimentation rate of Kearl Lake should be included. • Total PAHs, dibenzothiophene, total naphthenic acids, sodium and salinity should be added to the IMF. • A suitable analytical method should be found for those substances used as targets which are shown to be below MDL. • There is insufficient data to establish the pre-disturbance state, making it difficult to meet the IMF's goal of maintaining natural conditions. A year with good data should be selected as a baseline around which to build the IMF. • Insufficient background research exists for the water quality overview, and there is heavy reliance on McEachren and Noton (2002) and AXYS (2005). Many referenced statements are out of context or missing sufficient information. • Indirect impacts on flow through muskeg dewatering may result in the red condition, even in the absence of direct withdrawals. This should be acknowledged in the IMF. • Water quantity objectives in the green condition are unclear. A percentage of mean monthly or mean summer flows should be used, rather than a percentage of instantaneous flow. • It is recommended that a depth:area relationship for Kearl Lake be presented to adequately assess changes to water level. Rather than percentiles, recurrence intervals should be used for changes to lake levels. • The zero value of the 7Q10 for Kearl Lake inflow is questioned. • The use of RAMP data to describe existing water quality is insufficient. Changes in parameters during overland flow are not captured by current RAMP monitoring, only seepage and direct discharge impacts are. This IMF is an opportunity to supplement RAMP monitoring using the Muskeg River as a test case to determine which of the three conditions (red, yellow, green) exist. • A reference or additional data is requested to support the statement that "peatland drainage may result in water quality exceedances for mercury and iron". • Non-RAMP water quality data (from AENV and various EIAs) should be summarized in an Appendix, to provide seasonally or monthly variability.

General Issues	Source of Advice	Specific Comments
Technical and Modelling Concerns Cont.	Fort McKay IRC	• Instead of a real-time approach to managing flows, a regulatory plan should be developed to limit the total amount of land removed from the effective drainage area of the watershed at any time. Management actions would be difficult to implement under the real-time approach proposed in the IMF. The proposed approach could be used to predict the changes in flow due to total muskeg area drained. A maximum increase of 15% of the green condition flows was recommended as acceptable. • The reliability of the HSPF model for management purposes is questionable. • Reach-specific water quality objectives should be determined for many of the parameters, not just several. Objectives should be determined for all reaches. • Existing water quality data were discussed only for the mouth of Muskeg River. Significant differences exist between this site and one upstream of Wapasu Creek, which may or may not be related to development. Future monitoring design and data analysis should be carefully reviewed. • It is unclear how the licensing of process-affected water and runoff capture will be managed during yellow or red conditions. It is unclear how weekly natural flow will be determined for an accurate determination of the flow conditions. • The impact of loss of muskeg on winter flows has not been adequately considered.
	Mikisew Cree FN	• No detailed understanding is provided of how water quality parameters interact with each other and of the dynamic interactions between water quantity and quality. A tremendous data collection effort and basic science understanding is required to create a meaningful IFN. • A better quantification of the uncertainty associated with the various targets is needed. • Reliance on dilution as a means to address water quality is inadequate, particularly considering mass loadings that may not be reflected in local concentrations. • Selection of the anti-degradation target of a 20% increase of peak/mean concentrations appears arbitrary and requires more evidence to support its use for all contaminants with varying toxicity levels. • Baseline conditions for the WMP should be established with the Mikasew Cree in order to determine ecosystem functioning and sustainability.
	ERCB	• Methods of calculating parameter values from long term monitoring data and the accuracy of the data have not been addressed. A high level of certainty is implied which may not be present in the use of models. • Provide further justification for the use of the desktop approach to IFN considering that limited winter discharge records (e.g. 10 years) exist for the Muskeg River.

General Issues	Source of Advice	Specific Comments
Technical and Modelling Concerns Cont.	ERCB Cont.	• Clarify why the criteria proposed for managing low discharges in the Muskeg River are more stringent than those proposed for the Athabasca River. • Provide rationale for the selection of 15% and 5% objectives for instantaneous flow. • Additional detail is required to describe Kearl Lake and its historic water levels. Provide the source of data for Tables 5.1 and 5.2, including length of historic records, methods of modeling. • Additional detail regarding the use of the HSPF model in deriving the information in Table 5.3 Water Quality Targets and Limits, including how the frequency, magnitude and duration of water quality values evaluated relative to background conditions. • Provide the rationale for selecting a 20% change from the background mean or peak concentration as the anti-degradation limit. • It is unclear whether a standard for calibration of HSPF models been adopted by AENV. There may not be uniformity of results for water quality modeling with different versions of HSPF being used for impact assessment of oil sands projects. • Provide additional information in Table 5.3 for limits or effects criteria for the Red management limits. It is unclear what is proposed for improving data gaps to make the Red Zone a practical management tool (e.g. reach specific objectives and PAHs). • AENV should eventually incorporate measures of sediment quality, which may require additional monitoring and work to establish targets and limits. • AENV should eventually incorporate targets and limits for dissolved metals. • A simple diagram and discussion that includes steps for use of adaptive management techniques are recommended. • Provide the best management practices to manage water quality and quantity of the Muskeg River.
Monitoring Concerns	Shell Canada	• It is unclear how the monitoring would be implemented (who does it, who pays) and what a risk management plan is.
	ACFN and Fort McKay IRCs	• Monitoring should also be required during the green condition. • Monitoring should require a higher frequency (more than 1/year), sampling during hydrologically similar/comparable times, sediment and macrophyte sampling, use of mass loading, and sites other than just the mouth. • A faster and more detailed timeline for Level 2 monitoring is recommended. • Monitoring plans should also include standard, comparable locations, accurate mass loading calculations, winter flows, and in locations not to be mined out in future. Consistent effort and methods should extend to lab analyses, detection limits, fish counts, gauging measurements, sampling water quality during same point in the hydrograph within a season, and water quality sampling throughout the year at representative times.

General Issues	Source of Advice	Specific Comments
Monitoring Concerns Cont.	Fort McKay IRC	• It is unclear who the investigator will be, who is intended to gauge the level of response required.
	Mikisew Cree FN	• The monitoring and implementation section is unclear. It is unclear how an understanding of environmental processes in the watershed will be developed and fed into monitoring. • It is unclear how Level 1 and 2 monitoring would ensure the ecological integrity of the watershed is not compromised by development.
	ERCB	• There are few actions or details identified for enhanced monitoring, preparation of a risk assessment plan or for mitigating impacts. A flow chart with a range of actions up to and including sample mitigations would be helpful. The sequence of submitting a monitoring plan, risk assessment plan and mitigation plan with estimated time lines should be more clearly identified (Figure 5.6). A concise discussion of how the IMF is to be implemented through the regulatory process is a key element missing. • It is unclear how the role of cumulative effects monitoring such as RAMP relates to on-site monitoring by operators in the IMF. • It is unclear how bio-monitoring data of RAMP or AENV might be used to validate and adaptively manage the modeled targets and limits set by AENV. AENV should obtain information from RAMP to help address regional environmental monitoring. RAMP monitoring programs should be evaluated for their ability to meet the IMF's objectives.
Editorial Suggestions	Petro-Canada Oil Sands Inc. (PCOSI)	• The IMF is too wordy and should be half its length.
	Shell Canada	• Slight changes to the definitions of the conditions are suggested. • The definition of ecological integrity should be revised slightly. • Slight revisions to the discussion on peak flows are suggested.
	ACFN and Fort McKay IRCs	• The IMF should clearly state that there will be no approvals of diversions, re-routing, or withdrawals from the mainstem. A clear definition of the term "mainstem" is needed. • Suggests renaming "Target" with "Limit" or "Threshhold". • Several minor editorial corrections are recommended.

General Issues	Source of Advice	Specific Comments
Editorial Suggestions Cont.	Mikisew Cree FN	• Definitions of ecological health and ecological integrity require clarification, as they currently overlap. • The definitions of water quality target, water quality limit and the yellow and red conditions require improvement and clarity.
	ERCB	• State in the introduction/background information that additional mining activity is not planned for the basin in the next two years (which approximates the time frame for development of the Phase 2 Management Plan). • Clarify in the introduction/background information whether AENV intends to manage the water quality and quantity of the Muskeg River throughout the basin or primarily at the junction of the Muskeg and Athabasca Rivers.
General Concerns	Syncrude Canada Ltd.	• The short review period during the holiday season precluded a detailed review and consideration of the IMF.
	Shell Canada	• It is unclear whether the new Syncrude mine has been publicly disclosed.
	Pembina Institute	• AENV should defer evaluation of Shell's expansion plans and the PetroCanada/UTS Fort Hills project until the cumulative impacts of these projects can be understood within the context of the IMF. • Every existing and planned oil sands mine should be reviewed to determine the cumulative impact on water quantity and quality, in order to suggest appropriate mitigative measures and/or management actions.
	ACFN and Fort McKay IRCs	• AENV should initiate a process to include the ACFN and other regional FN in the development of the long-term WMP. It is unacceptable to defer this to a CEMA working group as 4 of the 5 FN are no longer part of CEMA and its process. • Regulators should seek Traditional Ecological Knowledge from FNs regarding the potential deepening of Kearl Lake.
	Fort McKay IRC	• Fort McKay expects to be consulted on any proposals to reroute the Muskeg River or to deepen Kearl Lake.
	Mikisew Cree FN	• AENV needs to continue to monitor the progress made by WITG on the long-term WMP and establish a parallel process with FN to develop the WMP, in the event that WITG cannot meet its commitments. • AENV needs to assess all the operating, approved and planned oil sands developments to determine the cumulative impact on water quality and quantity. • The IMF needs to clearly state that no major management decisions or approvals (including the Jackpine expansion plans) regarding diversions or rerouting on the mainstem of the Muskeg River will occur until a new policy is in place.

General Issues	Source of Advice	Specific Comments
General Concerns Cont.	ERCB	• Insufficient time for meaningful review and input. Additional review and consultation are required. • Identify who the affected stakeholders are. • The IMF overstates the consultation that occurred between AENV, industry other regulatory agencies. Opportunity was not given to these stakeholder groups to review draft reports or meet with AENV. Review of draft material was only possible after Dec. 20/08. The IMF does not recognize key input from CEMA's WITG to AENV. This includes the WITG request to complete an integrated IMF that addresses water quality and quantity throughout the basin, not just at the junction of the Muskeg and Athabasca Rivers. WITG also provided input to AENV asking for the IMF to be broadened beyond the management of water quality and quantity.

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